THE

JOURNAL OF GAS LIGHTING,

WATER SUPPLY, & SANITARY IMPROVEMENT.

VOL. XX. No. 494—23RD YEAR.] LONDON, SEPTEMBER 12, 1871. [Subscription per Annum. { 15s. in Advance. 18s. Credit.] DOUBLE No. Price 1s.

RAMSAY'S NEWCASTLE CANNEL COAL. Analysis—10,000 cubic feet of gas per ton of coal; 26-candle gas; 13¼ cwt. coke per ton of coal.

RAMSAY'S PATENT CONDENSED COKE.
DO. GARESFIELD COKE.

RAMSAY'S FIRE-CLAY ARTICLES.

GAS-RETORTS, introduced 1828. FIRE-BRICK WORKS, established 1804. FIRE-CLAY SANITARY PIPES, CHIMNEY-TOPS, and all Goods made of Fire-Clay. The Fire-Clay is worked from Blaydon Main Colliery, is of excellent quality, and no expense spared in perfecting every article. The FIRE-BRICKS (marked "RAMSAY") are to be seen in all parts of the world, and the Works are the most extensive in the Kingdom.

Manufactories—Derwenthaugh, Swalwell, and Hebburn Quay, near Newcastle-on-Tyne; and London Wharves—Falcon Wharf, No. 80, Bankside; and Honduras Wharf, Cubit Town. Large stocks kept.

Address G. H. RAMSAY, NEWCASTLE-ON-TYNE.

GEORGE GLOVER & CO.,

Patentees of the Standard Gasometers for the Government, and of the

IMPROVED DRY GAS-METERS.

These Meters are warranted to measure correctly and not to vary. Their acknowledged superiority has brought them into general use more rapidly than any Meters hitherto manufactured.

To meet the increasing demand, G. GLOVER AND Co. have just entered on possession of extensive premises adjoining their present Works in Ranelagh Road, and they are now prepared to execute promptly, orders to any extent. They keep in stock all sizes of Meters up to 200 lights. In cases of haste, on the receipt of a telegram early on one day, their Meters can be delivered next day in any part of England, and in the large towns in Scotland.

Particulars and lists of prices forwarded on application to—

RANELAGH ROAD, PIMLICO, LONDON, S.W.;
236, GEORGE STREET, GLASGOW;
OR
15, MARKET STREET, MANCHESTER.

COWEN'S PATENT FIRE-CLAY RETORTS.

JOSEPH COWEN and CO.,

BLAYDON BURN, NEAR NEWCASTLE-ON-TYNE,

Were the only parties to whom a PRIZE MEDAL was awarded at the GREAT EXHIBITION of 1851, for "GAS-RETORTS and OTHER OBJECTS in FIRE-CLAY," and they have also been awarded in the INTERNATIONAL EXHIBITION of 1862, the PRIZE MEDAL for "GAS-RETORTS, FIRE-BRICKS, &c., for EXCELLENCE of QUALITY."

J. C. and Co. have been for many years the most extensive Manufacturers of Fire-Clay Retorts in the United Kingdom; and orders for Fire-Clay Retorts of all shapes and dimensions, Fire-Bricks, and every other article in Fire-Clay, are promptly executed at their Works as above.

COWEN'S GARESFIELD COALS.
Coal Office,
QUAY SIDE, NEWCASTLE-ON-TYNE.

FIRST PRIZE IN THE PARIS EXHIBITION.

JOHN RUSSELL and CO.,

THE OLD TUBE-WORKS,
CHURCH HILL, WEDNESBURY;
ALMA WORKS,
WALSALL, STAFFORDSHIRE;
and 69, UPPER THAMES STREET, LONDON,

Original Manufacturers of Wrought-Iron Gas-Tubes, and Holders of the present Patents; Inventors and First Makers of LAP-WELDED FLUES for Steam-Boilers.

J. R. and Co. make all kinds of Tubes and Fittings for Gas, Steam, and Water, and the largest orders may be executed in a few days.

Gun Metal, and all other kinds of Cocks, Stocks, Dies, and Taps, Galvanized Tubes, &c.

N.B.—All goods thoroughly tested before sent out, and warranted.

JOHN BENT & SON,

WET AND DRY GAS-METER AND STREET-LAMP MANUFACTURERS,

BELL BARN ROAD, BIRMINGHAM.

ESTABLISHED 1830.

All materials found for the alteration of Public Lamps for lighting with the Rod. Regulators with Lava Burners.

BLAYDON BURN AND LOW BENWELL FIRE-CLAY RETORT AND FIRE-BRICK WORKS,
NEAR NEWCASTLE-ON-TYNE.

WILLIAM COCHRAN CARR begs most respectfully to thank the Metropolitan, Provincial, and Continental Gas Companies for their patronage for several years past, and to intimate that he has rebuilt and enlarged his extensive premises for the manufacture of CLAY RETORTS; and that he is now prepared to execute the largest orders with punctuality and despatch. Orders for FIRE-CLAY RETORTS, of all shapes and sizes, FIRE-BRICKS, and all other articles in Fire-Clay, executed on the shortest notice, and on the most reasonable terms.

London Agents: JAMES LAWRIE & CO.,
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SCOTTISH CANNEL COAL.

J. & W. ROMANS, Consulting Gas Engineers and Coal Factors, of Edinburgh and London. CONTRACT for supplying any quantity of COAL and CANNEL.

They are also Contractors for leasing Gas-Works, for supplying, erecting, or repairing gas apparatus and fire-clay goods.

Messrs. ROMANS, being lessees of several Gas-Works, have their Cannels tested in the ordinary working process, thus securing for their customers a guarantee beyond mere laboratory experiments.

Analysis, prices, and other information will be forwarded on application to their Offices, 8, Forth Street, EDINBURGH; 1, Walbrook, Mansion House, LONDON, or to the "Crown Wharf," Thomas Street, Limehouse, LONDON, where stocks of house, steam, and gas coal are always on hand.

Coal, machinery, fire goods, &c., shipped to all parts of the world.

LESMAHAGO GAS COAL,

AUCHINHEATH COLLIERY,

LESMAHAGO N.B.

JAMES FERGUSON & CO.

LESSEES SINCE 1832.

LONDON AGENTS:
JAMES LAWRIE & CO.,
63, OLD BROAD STREET, E.C.

CONTINENTAL AGENTS:
LA COUR & WATSON,
LEITH.

GEORGE GLOVER AND CO.,

Patentees of the Standard Gasometers for the Government,

TWO MEDALS,

LONDON, 1862.

HAVE OBTAINED THE

HIGHEST

PRIZE

FOR

SILVER MEDAL,

PARIS, 1867.

IMPROVED DRY GAS-METERS AND GASOMETERS,

AT THE

PARIS EXHIBITION.

RANELAGH WORKS, RANELAGH ROAD, PIMLICO LONDON, S.W.;
AND 236, GEORGE STREET, GLASGOW.

WHITEHOUSE AND COMPANY, LIMITED,
GLOBE TUBE-WORKS, WEDNESBURY; & VICTORIA TUBE-WORKS, GREAT BRIDGE,
MANUFACTURERS OF
PATENT WELDED WROUGHT-IRON TUBES,
FOR GAS, STEAM, AND WATER;
STEAM-COCKS, AND ALL KINDS OF GAS-JOINTS.
LONDON OFFICE: 115, LEADENHALL STREET, E.C.

HENRY HOWARD & CO.,
COOMBS WOOD PATENT TUBE-WORKS.
OLD HILL, near DUDLEY,
MANUFACTURERS OF
HOWARD'S PATENT IMPROVED WROUGHT-IRON TUBES,
FOR GAS, STEAM, AND WATER;
Also **ORDINARY WELDED WROUGHT-IRON TUBES and FITTINGS,**
FOR GAS, STEAM, & WATER, EITHER BLACK, GALVANIZED, OR ENAMELLED.
CORE BARS FOR IRONFOUNDERS, STOCKS, TAPS, AND DIES, IRON COCKS, &c.
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SILVER MEDAL, PARIS EXHIBITION, 1867.
LLOYD AND LLOYD,
ALBION TUBE-WORKS, BIRMINGHAM,
MANUFACTURERS OF
WROUGHT-IRON TUBES AND FITTINGS
For Gas, Steam, Water, &c.
SOLE LICENSEES AND MANUFACTURERS for the United Kingdom of
THE LAVENANT PATENT ENAMELLED TUBES AND FITTINGS.
LAP-WELDED IRON & HOMOGENEOUS METAL TUBES
For Locomotive, Marine, and Stationary Boilers.
Boiler-Tube Ferrules, Gun-Metal Gland Cocks, Water-Gauges, Whistles, &c.; Stocks, Taps, and Dies for Screwing, and Gas-Fitters Tools of all kinds.
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WAREHOUSES:
LONDON: No. 157, Upper Thames Street, E.C. LIVERPOOL: No. 63, Paradise Street. MANCHESTER: Barlow's Croft, Chapel Street, Salford. PARIS and LILLE.

WILLIAM INGHAM AND SONS,
WORTLEY FIRE-BRICK AND RETORT WORKS,
Near

Leeds.
W. INGHAM and SONS, having for many years been extensively engaged in the Manufacture of
RETORTS AND FIRE-BRICKS FROM THE CELEBRATED WORTLEY FIRE-CLAY,
beg to call especial attention to their RETORTS, which have for many seasons proved to be unsurpassed in quality by any in the Kingdom, their FREEDOM FROM CRACKS and the ADHESION OF CARBON rendering them worthy the attention of all parties interested in the making of Gas.
The Works are of such magnitude as to ensure the prompt execution of orders to any extent.
Estimates for Setting, or Bricklayers sent when required.
GAS OVENS IN SEGMENTS OF EQUAL QUALITY.
A large Stock of Fire-Bricks, Fire-Clay, Terra Cotta, and Drain-Pipes of all Sizes kept in London at Mr. ALFRED WILLIAMS, Wharf, 64, Bankside, Southwark, where all particulars of Prices, &c., may be obtained.
N.B.—*Export orders continue to have prompt attention.*

TRADE MARK.

THE MEDAL FOR 1862.
The only Prize Medal awarded for TUBES & FITTINGS.
CROWN TUBE-WORKS,
WEDNESBURY, STAFFORDSHIRE.
WAREHOUSE: SOUTHWARK STREET, LONDON.

JAMES RUSSELL & SONS, LIMITED,
PATENTEES & FIRST MAKERS OF WROUGHT-IRON TUBES,
ONLY MAKERS OF HOMOGENEOUS METAL TUBES.
MANUFACTURERS OF
TUBES and FITTINGS for GAS, STEAM, and WATER;
LAP-WELDED, LOCOMOTIVE, MARINE, and other BOILER TUBES;
HYDRAULIC TUBES, BEDSTEAD TUBES, WELL TUBES, TELEGRAPH POSTS, COILS, &c.;
GAS-FITTERS TOOLS, VALVES, COCKS, &c.

THOMAS PIGGOTT & CO.,

(Established 1822,)

SPRING HILL, BIRMINGHAM,

MANUFACTURERS OF

TELESCOPIC & SINGLE GASHOLDERS,

CAST & WROUGHT IRON TANKS FOR DITTO;

PURIFIERS, CONDENSERS, SCRUBBERS, RETORTS, VALVES;

IMPROVED WROUGHT-IRON RETORT-LIDS, CROSS-BARS, & SCREWS;

AND GAS APPARATUS OF EVERY DESCRIPTION.

CAST AND WROUGHT IRON GIRDERS, BRIDGES, AND ROOFS,

STEAM-ENGINE BOILERS, & GENERAL WROUGHT-IRON WORK.

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D. BRUCE PEEBLES & CO.,

ENGINEERS, WET AND DRY GAS-METER MANUFACTURERS,

BRASSFOUNDERS, & GAS APPARATUS MANUFACTURERS,

FOUNTAINBRIDGE WORKS, EDINBURGH.

SOLE MANUFACTURERS OF

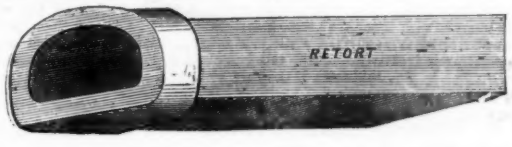
Peebles' Patent Wet and Dry Gas-Meters in Tin-Plate Cases, with Tongue and Groove Joints.

IMPROVED WET METERS IN CAST-IRON CASES.

STATION-METERS, GOVERNORS, EXPERIMENTING METERS, PHOTOMETERS, PRESSURE-GAUGES, &c.

KING BROTHERS,

STOURBRIDGE FIRE-BRICK AND RETORT WORKS.

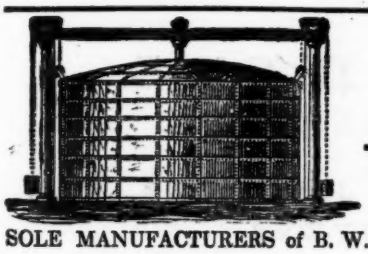


KING BROTHERS beg especially to call the attention of Gas Companies to the superiority of their Retorts, which are made from the celebrated STOURBRIDGE FIRE-CLAY. Mr. King has patented a Kiln for burning Retorts, by which Patent all Cold Air is excluded from the Kiln while burning, thus rendering them FREE FROM CRACKS AND CORRECT IN FORM. By great care in Manufacturing, combined with the advantages in burning, a VERY SMOOTH SURFACE is obtained, rendering them less liable to carbonize.

Retort Ovens, Fire-Bricks, Guards, Saddles, Rabbitted Bars, Flues, and Quarries, are all Manufactured of the same quality of Clay.

Every Retort and Brick is branded "King Brothers, Stourbridge."

Agent in Ireland—Mr. JAMES FURNESS, No. 3, FOWNES STREET, DUBLIN.



IMPROVED GAS APPARATUS,

FOR CITIES, TOWNS, VILLAGES, &c.,

INVENTED AND MANUFACTURED BY

W. C. HOLMES & CO.,

WHITESTONE IRON-WORKS, HUDDERSFIELD.

SOLE MANUFACTURERS of B. W. THURSTON'S IMPROVED SCRUBBER, CONDENSER, and WASHER, in use in many of the principal Gas-Works on the Continent.

PATENTEES of the IMPROVED COMBINED PURIFYING APPARATUS, so eminently adapted for Exportation.

ESTIMATES, PLANS, and SPECIFICATIONS PREPARED for BUILDINGS and APPARATUS.

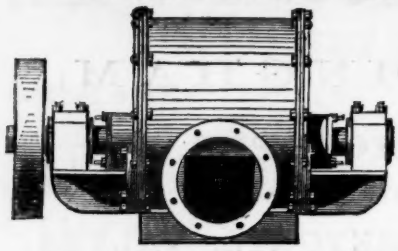
Prospectus, Price Lists, &c., on application.

LONDON OFFICES—57, GRACECHURCH STREET, CITY.

*** *Please address letters to Huddersfield.*

REFERENCES TO NEARLY 300 GAS-WORKS.

BEALE'S GAS-EXHAUSTER IMPROVED.



FROM 250 TO 250,000 CUBIC FEET PER HOUR.

Since Mr. BEALE'S retirement, the Oldest Makers are

J. BURTON, SONS, AND WALLER,

MAKERS OF ENGINES, MACHINERY, and IRONWORK for GAS-WORKS.

Efficient and durable TAR, LIQUOR, and SYPHON PUMPS.

GAS-VALVES in stock, 2 inches to 30 inches.

SELF-ACTING BYE-PASS VALVES, with Lid and Relieving Lever,

ROTATORY, TUMBLER, and CAPILLARY WATER DISTRIBUTORS for SCRUBBERS.

EXHAUSTERS from 3000 to 30,000 per hour in stock.

HOLLAND STREET, BLACKFRIARS, LONDON, S.E.,

Between Blackfriars' and Southwark Bridges.

C. & W. WALKER'S

DOUBLE-FACED GAS-VALVES FOR LARGE MAINS.

These Gas-Valves for large bores are specially constructed of unusual strength and solidity. The Valve itself is a rigid wedge of cast iron, having two perfectly scraped surface facings, fitting between the two in the body, which are also surfaced. They are guaranteed absolutely tight under any chemical or other test for mains of the largest diameter, at a very moderate price.

Midland Iron-Works, Donnington, near Newport, Shropshire; 8, Finsbury Circus, London.

LAMBERT BROTHERS, WALSALL.

ALPHA TUBE & FITTING WORKS

E. J. & J. PEARSON,

DELPH & TINTAM ABBEY FIRE-CLAY & BRICK WORKS,

STOURBRIDGE,

PROPRIETORS OF

BEST GLASS-HOUSE POT & CRUCIBLE CLAY;

MANUFACTURERS OF

GLASS-HOUSE POTS, CRUCIBLES, GAS-RETORTS, & FIRE-BRICKS OF EVERY DESCRIPTION.

1862.

PATENT ANTIMONY PAINT.

CLASS II.

MADE ONLY BY

GEORGE HALLETT & CO.,

296, ROTHERHITHE, LONDON, S.E.

This Paint having been in general use over nine years (especially in some of the principal Gas-Works), and proved itself the best light-coloured Paint produced for resisting the influence of vitiated atmospheres, it is important that its qualities should be more widely known.

It is not discoloured like white lead in a sulphuretted atmosphere, nor washed off like white zinc; and its light colour reflecting heat, produces much less expansion of gas in holders painted with it than with dark colours, besides rendering them much more sightly. Its specific gravity is so much below white lead that the same weight will cover one-third more surface, while it is equal in body; and its price being about the same (30s. per cwt.), it is actually one-third cheaper. From experience, its manufacture is greatly improved, and it is quite suitable for all purposes in which white lead is employed.

Reference is kindly permitted by the Engineers of the City of London, Commercial, London, and Surrey Consumers Gas Companies, who pronounce it the best Paint known for their purposes.

N.B.—Antimony Paint, COVERING SO MUCH MORE WORK, costs about 20s. per cwt., as compared with White Lead at 30s. per cwt.; a similar economy arises from its use in Steam and Gas Joints, for which purpose it is superior to White Lead.

LIVESEY FIRE-CLAY WORKS,

NEAR BLACKBURN, LANCASHIRE.

(ESTABLISHED 1835.)

ORLANDO BROTHERS,

MANUFACTURER OF PATENT CLAY RETORTS,

AND EVERY DESCRIPTION OF

TUBULAR GLAZED SEWERAGE PIPES, BENDS, JUNCTIONS, ETC.

FIRE-BRICKS, TILES, BLOCKS, AND CHIMNEY-TOPS.

As Trustees of the late ORLANDO BROTHERS, we most respectfully announce that we intend to continue the above business, under the name of ORLANDO BROTHERS, in which name all communications must be addressed.

We trust that we shall receive a continuance of the same support which was given to our late father.

We are, yours most respectfully,

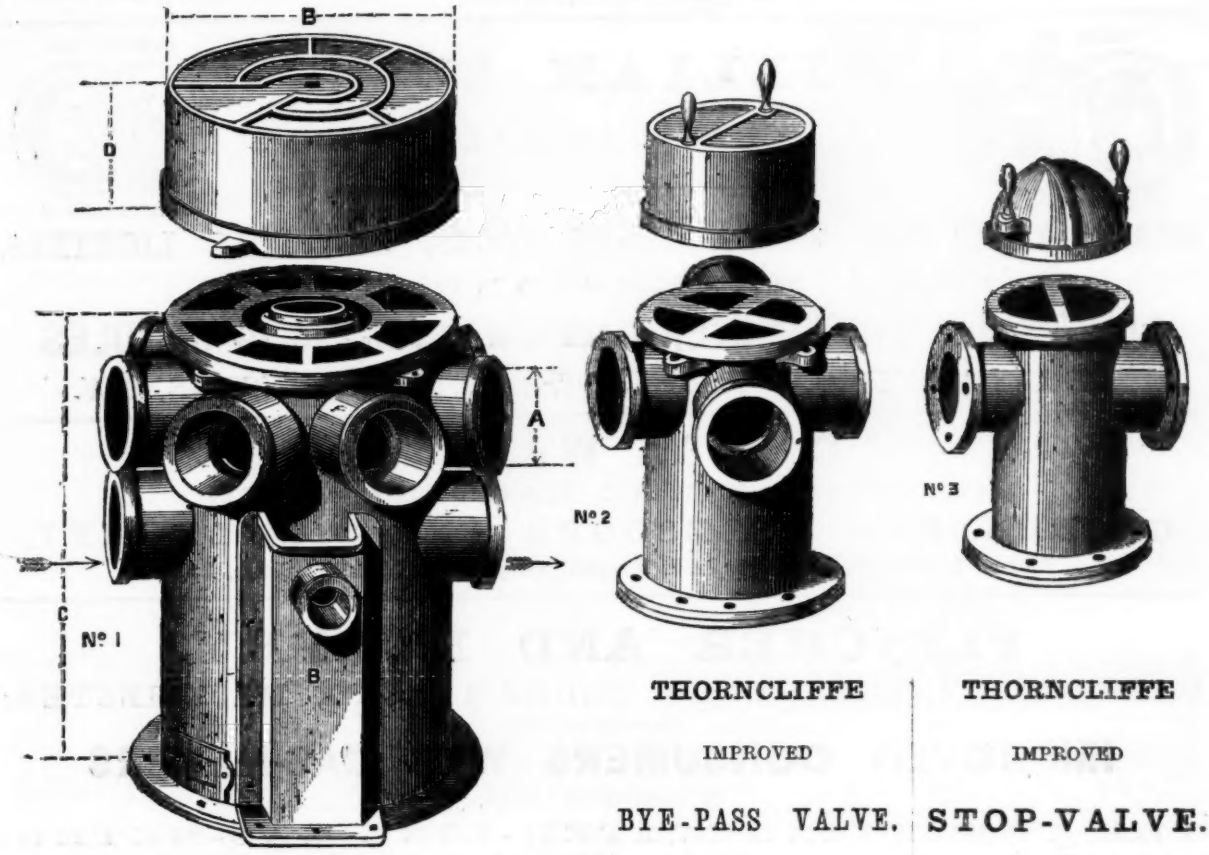
ORLANDO BROTHERS.
FRANCIS W. BROTHERS.
COLIN BROTHERS.

THE THORNCLIFFE IMPROVED CENTRE-VALVE,

MANUFACTURED BY

MESSRS. NEWTON, CHAMBERS, & CO.,

THORNCLIFFE IRON-WORKS, NEAR SHEFFIELD.



Sizes of the

THORNCLIFFE IMPROVED CENTRE-VALVE.

		Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.
A	Bore of Pipe...	4	5	6	7	8	9	10	12
B	Diam. of Body.	16	20	23	26	28	31	34	40
C	Height of Tank.	33	35	38	43	46	48	51	56
D	Depth of Cover.	8	9	10	11	12	13	14	16
	Total height...	41	44	48	54	58	61	65	72

THORNCLIFFE IMPROVED BYE-PASS VALVE.

SIZES

From 3 ins. upwards.

THORNCLIFFE IMPROVED STOP-VALVE.

SIZES

From 3 ins. upwards.

In all cases the Covers are cast heavy enough to resist any required pressure.

The advantages derived from the adoption of these Valves are so manifest and cardinal that in the immediate character of the change—the simplicity of the machine—the facility affording for cleaning out connexions between Valve and Purifier—the perfect collection and delivery by suitable overflow of the ammonia, at a greatly diminished depth from ground-line over the old form of Valve—the advantage of connecting on the same level, and at any angle, or opposite to each other, the inlet and outlet pipes without dip or rise—the clear acquisition of space in the purifying-house, by being able to place the boxes nearer together, the new Valve being entirely under the floor—and lastly, though of the greatest importance, the passage of crude and unpurified gas during the change is minimized to the merest fraction, thus preventing the fouling by impure gas the delicate machinery and easily affected exposed movements of the station-meter, thereby preventing the introduction of the enemy (unpurified gas) into the gasholder. Also a dead abutment is offered to all back pressure, imparting thereby to the gauges, governors, and hydraulic seals, a steadiness of action never realized with the once famous, but now fast becoming obsolete, Hydraulic Centre-Valve.

These Valves may be made of any size to suit any position of boxes, to stand any amount of pressure, warranted and tested with gas before leaving the manufactory, prepared to work any number of boxes in rotation—say, two, three, four, five, six, or eight—and for all Valves above 12-inch ports a suitable rack-and-pinion movement is attached if preferred. These Valves (specially arranged) are applicable to inlet or outlet pipes of gasholder, to act as Bye-pass Valves to meters, governors, exhauster, condensers, scrubbers, washers, driers, and duplicate systems of hydraulic main; also to act as Stop-Valves on special mains about the works. Where it is important no impediment be offered to tar or ammoniacal liquor, the same having uninterrupted flow to the general tar-well on the works, and for which purpose the slowly changed, often disordered, and at all times obstructive Slide-Valve (challenging the best of them) is superseded by the exceedingly simple, instantaneously changed Dome-Top Valve, which also carries so marked an index, whether open or shut, at any distance from close observation, providing the Valve can be seen at all. See sketch in perspective, No. 3.

London Office—34, LONDON WALL, MOORGATE STREET, E.C.

JOHN HALL & CO.,

STOURBRIDGE,

MANUFACTURERS of FIRE-BRICKS, LUMPS, & TILES,

AND EVERY DESCRIPTION OF FIRE-CLAY GOODS.

N.B.—A Stock of 15 and 16 in. CIRCULAR RETORTS always on hand. Other kinds made to order on short Notice.

PARIS, 1867.

CLASSES 24 and 53.

WILLIAM SUGG,

GAS ENGINEER.

LONDON, 1862.

CLASSES 13 and 31.

PUBLIC LAMP GOVERNORS, LEVER COCKS, AND POLE LIGHTERS,

LAMP METERS AND BOXES.

LOWE'S JET PHOTOMETERS CAN NOW BE RATED TO 14 CANDLES.

VINCENT WORKS, VINCENT STREET, WESTMINSTER, S.W.

C. & W. WALKER

CONSTRUCT THE LARGEST SIZED

GASHOLDERS, TELESCOPE AND SINGLE-LIFT,

Midland Iron-Works, Donnington, near Newport, Shropshire; 8, Finsbury Circus, London.

FLETCHER AND MURPHY,

GARRATT STREET WORKS, OLDHAM ROAD, MANCHESTER;

Manufacturers of

IMPROVED CONSUMERS WET GAS-METERS

IN CAST-IRON CASES,

THE UNVARYING WATER-LINE GAS-METER,

AND

IMPROVED DRY GAS-METERS;

STATION-METERS OF ALL SIZES, with PLANED JOINTS;

GOVERNORS, PRESSURE AND EXHAUST REGISTERS, TEST HOLDERS,

And all kinds of Experimental Gas Apparatus.

MESSRS. NEWTON, CHAMBERS, & CO.,

THORNCLIFFE IRON-WORKS AND COLLIERIES,

NEAR SHEFFIELD.

CELEBRATED SILKSTONE GAS COALS.

Analyses by F. J. EVANS, Esq., Chartered Gas Company, Horseferry Road, Westminster:—

(COPY.)

Description.	Cubic Feet of Gas per Ton of Coals.	Illuminating Power in Candles.	Coke per Ton of Coal used, Cwt.	Ash in Coke per Cent.	Sulphur in Coa per Cent.
Best Silkstone . .	10,900	17·0	12·8	2·6	1·7
Norfolk Silkstone . .	11,000	15·94	12·5	4·4	1·64
Silkstone Brights . .	11,500	14·5	12·6	7·4	1·85
Silkstone Nuts . .	10,800	15·85	12·66	6·0	0·69

NOTE.—The illuminating power of the Gas was tested by the standard burner now used in London by the Gas Referees, under the City of London Gas Act, 1868.

Horseferry Road, Westminster, March, 1870. (Signed) F. J. EVANS.

OFFICES, 34. LONDON WALL, CITY, E.C.

TANGYE BROTHERS & HOLMAN,

10, LAURENCE POUNTNEY LANE, LONDON, E.C.;

And BIRMINGHAM (TANGYE BROS.), CORNWALL WORKS, SOHO.

SOLE MAKERS OF

MORTON'S PATENT SELF-SEALING RETORT-LIDS,

WITH HOLMAN'S PATENT ECCENTRIC FASTENINGS.

Over 1000 of the Patent Retort-Lids and fastenings already supplied to the great works of The Gas Company at Beckton.

Several hundreds in use at the works of the London Gas Company.

FIG. 1.

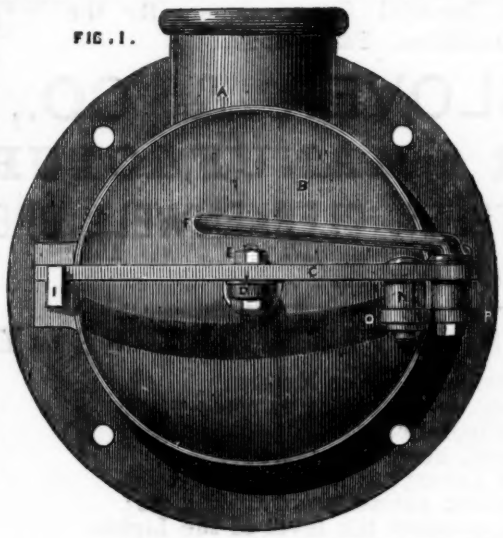
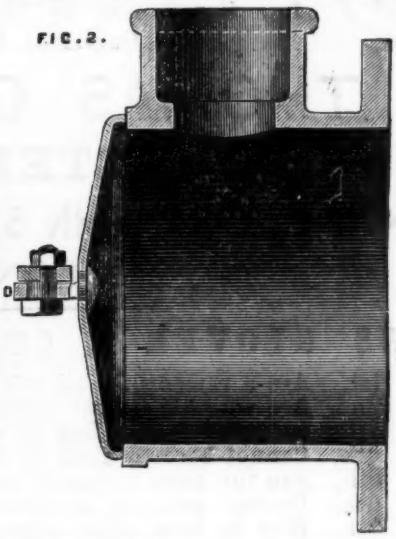


FIG. 2.



Adopted in the Gas-Works at

LIVERPOOL,
DUBLIN,
NOTTINGHAM,
ST. ALBANS,
BURSLEM,
BOURNEMOUTH,
WINDSOR,
BOSTON,
&c., &c.

THE "SPECIAL" STEAM-PUMP

IS THE

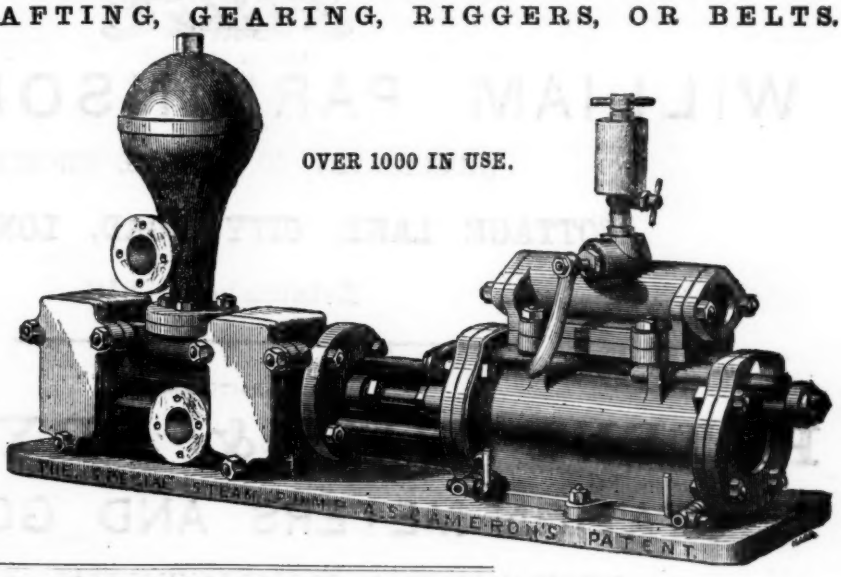
BEST PUMP FOR PUMPING AMMONIACAL LIQUOR, TAR, AND WATER IN GAS-WORKS

The "SPECIAL" Steam-Pump is adapted for all ordinary purposes for which Steam-driven Pumps are used. It is economical in first cost, occupies very little space, and the wear and tear is reduced to a minimum, because there is absolutely no extraneous gear.

REQUIRES NO SHAFTING, GEARING, RIGGERS, OR BELTS.

Adopted in the following Gas-Works:—

Aylesbury Gaslight and Coke Company.
Alliance and Dublin Gas Company.
Bolton Gas-Works.
Burslem and Tunstall Gas Company.
Brighton Gaslight and Coke Company.
Bury St. Edmund's Gas Company.
Burnley Gas Company.
Bradford Gaslight Company.
Corporation Gas-Works, Stockton.
Chartered Gas Company, Westminster.
Cork Gas-Works.
Dewsbury and Batley Gas Company.
Dublin Consumers Gaslight and Coke Company.
Dunstable Gas-Works.
Imperial Gas-Works, St. Pancras.
Ipswich Gas-Works.
Kingston-upon-Hull Gaslight Company
London Gaslight Company, Nine Elms
Lewes Gas-Works.
Louth Gas Company.
Middlesbro' Gas-Works.
Northampton Gas Company.
Phœnix Gas-Works, London.
Richmond Gas Company.
Rio de Janeiro Gas Company.
Reading Gas-Works.
Shipley Gas-Works, near Bradford.
St. Albans Gas-Works.
Sutton, Southcote, and Drypool Gas Company, Hull.
St. Helen's Gas Company, Lancashire.
Windsor Royal Gaslight Company.
Wandsworth and Putney Gas Company.
Woolwich Equitable Gas Company.
Western Gas-Works, Kensal Green.



OVER 1000 IN USE.

IMPORTANT TESTIMONIALS.

Manager's Office, Local Board Gas-Works, Middlesborough, March 19, 1868.

Dear Sirs,—In reply to your inquiry, I beg to say that the "Special" Steam-Pump, which you supplied to these works some months ago, has been at work ever since for pumping tar and ammonia water. I like it well, and am more than satisfied, for I am really pleased with its mode of doing double duty.

I am, very respectfully yours.

JOHN DUNNING, Manager.

Messrs. Tangye Brothers and Holman.

Richmond Gas Company, Manager's Office, Gas-Works, Richmond, June 17, 1868.

Dear Sirs,—I have the pleasure in stating that the three "Special" Steam-Pumps which we have in use—viz., one for water, one for pumping liquor through the scrubbers, and the other for filling tar barges, &c., are working well in every respect, and, I think, cannot be too highly recommended.

Yours truly,

JAMES ELDRIDGE, Manager.

Messrs. Tangye Brothers and Holman.

Sutton, Southcote, and Drypool Gas Company, Hull, May 1, 1871.

Gentlemen,—In reply to your note No. 410, April 29, I am very glad to inform you, that in a few hours after I got the pump started, and after I had written you, it did its work beautifully, and has continued to do so, throwing one day 4000 to 5000 gallons per hour, although you say 3250 gallons is its capacity. It is a splendid pump, the best I ever saw, and has just emptied a tank 82 feet diameter by 16 feet deep in 100 hours. I should have written to you some days ago had your note come earlier.—Yours truly,

F. W. OLDFIELD, Manager.

London, 1851. New York, 1853. Paris, 1855. London, 1862.

Dublin, 1865.

The SIX MEDALS AWARDED to THOMAS GLOVER for

PATENT DRY GAS-METERS,

The latter being the Highest Medal awarded for Dry Gas-Meters by the Imperial Commissioners for the Universal Exhibition, Paris, 1867.

Paris, 1867.

THOMAS GLOVER & CO.,

DRY GAS-METER MANUFACTURERS,

214 TO 222, ST. JOHN STREET, CLERKENWELL GREEN,

LONDON, E.C.

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2nd, Are suitable for all climates, whether hot or cold;
3rd, Incur no loss of Gas by evaporation;
4th, Cannot become fixed by frost, however severe;
5th, Are the most accurate and unvarying measurers of Gas;
6th, Prevent jumping or unexpected extinction of the Lights;
7th, May be fixed either above or below the level of the Lights;
8th, Cannot be tampered with, without visibly damaging the outer case;
9th, Will last much longer than Wet Meters;
10th, Will not cost more than one-half for repair that Wet or Water Meters do;
Are upheld for five years without charge.

WILLIAM PARKINSON & CO.,

(SUCCESSORS TO SAMUEL CROSLEY,)

COTTAGE LANE, CITY ROAD, LONDON, E.C.

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MANUFACTURERS OF

PATENT WET & DRY METERS,

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PRESSURE REGISTERS, GAUGES,

EXPERIMENTAL METERS, PHOTOMETERS, GASHOLDERS, &c., &c.

WATER METERS.

W. P. & Co. beg to state that they are now prepared to supply Station-Meters with planed joints.

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TO CORRESPONDENTS.

No notice can be taken of anonymous communications. Whatever is intended for insertion, must be authenticated by the name and address of the writer; not necessarily for publication, but as a guarantee of good faith.

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The subscription is 15s. per annum if paid in advance during the month of January, or 18s. credit, in two sums of 9s. each, payable in July and January of each year.

All communications for the Editor should be addressed "No. 42, Parliament Street, London, S.W."

Remittances for subscriptions and orders for advertisements should be addressed to the publisher, William B. King, 11, Bolt Court, Fleet Street, London, E.C.

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THE JOURNAL OF GAS LIGHTING,

WATER SUPPLY, & SANITARY IMPROVEMENT.

TUESDAY, SEPTEMBER 12, 1871.

Notes upon Passing Events.

The Earl of Shaftesbury has made philanthropy a profession, and, according to the rules by which his class are supposed to be influenced, has made a very good thing out of it. Not money—peers, and especially ultra-religious peers, are not supposed to care for money—but he has obtained influence, patronage, and certain crops of applause. His lordship is an accomplished platform orator, and knows exactly where and how to make his audience cheer, smile, and even roar with laughter. But it is impossible in these semi-theatrical performances to be always consistent. For instance, when, in his last speech in the House of Lords, Lord Shaftesbury expressed his dissatisfaction with the work of the session, and particularly with the neglect of any attempt at sanitary legislation, his lordship did not hint what form he would have this legislation take; he studiously dealt in those generalities which are so easy, so meaningless, although often very effective in debate. But when Lord Shaftesbury went to Glasgow—a city conspicuous for its magnificent water supply, its dirt and unhealthiness, for its piety and its drunkenness, its strict observance of Sunday and its enormous consumption of whisky—he told a story that illustrated in a perfect manner how much easier it is to "*orate*" on sanitary reform than to frame a practical workable Act of Parliament. Lord Shaftesbury related that, in the course of his philanthropic labours, he persuaded the tenant of a very dirty tenement in St. Giles's to allow him to whitewash his rooms at his lordship's expense; but on the next visit the house was found dirtier than ever. On asking for an explanation, the St. Giles's man answered that, finding the appearance of clean whitewash very cold, he had asked a neighbour—a sweep—to give the walls a few touches with his brush!! If Lord Shaftesbury had added a few pennyworth of yellow ochre or a little soot to the first application of whitewash, he would have produced a warm yellow or grey colour, and saved his cleaning scheme from total failure. But, after all, it is the old story—one man can lead an ox to water, a dozen cannot make him drink. Miss Edgeworth, when Lord Shaftesbury was a little boy, in one of her famous Irish stories, describes the disappointment of a well-meaning landlord who had built a slated cottage, with chimneys and several rooms, for his old nurse, who at once stopped up the chimneys for warmth, and pigged with all her family in one room full of smoke. It is impossible to compel people to be clean, to wash, to make use of ventilation in order to obtain fresh *clean* air, or to use in preference wholesome food, unless they are convinced of the importance of those assistants, if not essentials of health. If we want illustrations at home of this ignorance, we may find it in grooms at high wages—a class who treat water as if it would poison their horses, and stop up, with great ingenuity, carefully devised contrivances for securing stable ventilation. Abroad, amongst the learned Germans, are to be found plenty of curious specimens to whom soap and water are unknown quantities, whose favourite food is the garbage of raw sausages, and whose ignorant terror of draughts is so great that they prefer to breathe foul air. For a good deal of the prejudice in England against sanitary reform, Lord Shaftesbury is himself answerable. He was an active member of the first Board of Health—that board which fell ignominiously because, under its patronage, most incompetent persons were employed to remedy undoubted sanitary evils. Board of Health created engineers executed sewer works which produced fevers, as at Croydon, and did not carry away sewage, and water-works, as at Rugby, which failed in water supply at the driest seasons, when it was most needed; and so on all over the country. With characteristic incorrectness, Lord Shaftesbury quoted to the House of Lords, Manchester, as a city better supplied with water than the metropolis. His lordship ought to have known that while the water supply of London has never failed, Manchester and all the adjacent towns, supplied on the same system, were put on short supplies of very turbid water during the summer of 1869. But then men of the order of mind of Lord Shaftesbury never listen to a fact that contradicts their preconceived theories. If the first Board of Health had employed competent servants, and executed its engineering works successfully, instead of making miserable failures in so many town, a good deal of jobbing and nepotism and arbitrariness might have been condoned. When Lord Shaftesbury talks of more decisive measures of sanitary reform, he means—and he is not far wrong—that the parochial authorities and municipal authorities are often not at all inclined to set in motion the sanitary powers placed in their hands; therefore his lordship inclines to a powerful central authority sitting in London, and sending forth its engineer or surveyor emissaries to carry out sanitary reform, whether the people like it or not. Before such powers are granted, the taxpayers and ratepayers will want to know "Who is your friend?"—what qualifications the advisers of the London Board have for setting every one to rights. Mr. Rawlinson is a great authority with the Health Department; but it appears, from the latest accounts, that Mr. Rawlinson's sewerage operations at the town of Alnwick are in the highest degree unsatisfactory. Mr. Simon is the great medical authority at the Health Department, and Mr. Simon is responsible for the preposterous clause of the Vaccination Act (rejected by a majority of one by the House of Lords) which enabled any one able to pay a pound fine to propagate small-pox—the fact being that Mr. Simon is so passionately fond of popularity among the humble classes (an amiable foible) that he cannot bear to contradict their prejudices. Dr. Farr is another pet of the governing powers—Dr. Farr, who invented the sensational trick of giving the nominal impurity of rivers in tons, and who holds a theory about the impurity of water once contaminated, in opposition to the most eminent chemist, as well as to the history of the world; for, if Dr. Farr's theory be true, the world ought to have been poisoned out of hand long before the words "sanitary reform" were invented. Let it be understood, we fully appreciate the importance of securing wholesome dwellings, good drainage, ample water supply, and the rational use of all fertilizing matter in every village and larger community. Education can do much in this way—investigation by competent authorities much; but we are not prepared to put despotic power in the hands of quacks like the noble army of martyrs who patronized, toadied, and followed Lord Shaftesbury's favourite sanitary apostle, Mr. Chadwick.

Mr. Edwin Chadwick, by-the-by, has, with customary assurance, written a letter to the newspapers to tell them how superior his Board of Health was to the present department, with the same

duties. Mr. Chadwick's Board made a great deal of noise, spent a great deal of money in printing, praising themselves, enunciating new fallacies, and in travelling expenses, but it would be difficult to show that they saved a single patient from cholera. The proceedings of the first Board of Health should be carefully studied, and as carefully avoided.

When shall we see the next financial mania of investment, and its certain consequence—a panic? This is as ordinary a topic, in certain circles, as the state of the crops. There are signs of folly floating on the surface of the speculative stream, which take most the character of mining ventures—a sort of lottery never entirely out of favour, for the simple reason that there are great prizes, at the rate of about 1 per cent., in all honest mining speculations. American, and especially Californian schemes have been introduced into the English market, or rather into the bosom of the English middle classes, with considerable skill. We would only put to those innocent individuals who expect to glean handsome profits where 'cute Yankees, amply provided with capital, have reaped the fields before them, the question that was put to a late marquis, when, fresh from the hands of his tutors, he proposed to ruin the betting-ring—"Pray tell me from "which of these 'cute professional gentlemen do you expect to "get an advantage?" Financially, panics have hitherto been almost decimal; therefore the time of speculation that prepares for the panic must be due. The present generation remembers 1825, 1837, 1839, 1847, 1857, and 1866.

The *Times* has lifted up its powerful voice against Mr. Street's Gothic design for the new Courts of Justice, on the ground that an enormous sum will be sunk in details of ornamentation, at which no one except an amateur will look when new, and which will be lost in dust and smoke within a very few years—with other objections to making a sort of town of buildings, instead of one imposing mass. There may be something in this. It will be remembered that Mr. Chancellor of the Exchequer Lowe and Mr. Layard, before he became an ambassador, proposed to adopt Inigo Jones's designs for the Palace of Whitehall to the Courts of Justice on an Embankment site. But, unfortunately for them, Mr. Field, the attorney, who was drowned the other day, was then alive, and under his management Sir Roundell Palmer upset the site and Inigo Jones's design at the same time. We fancy that, however sound the agitation may be, it is too late, and that it is only taken up by the *Times* as one of the subjects fit for the silly season.

As a rule, we are optimists, and do not put faith in theories involving the decline of the civilized races of the world; but we must confess that the latest reports from Switzerland are very disheartening. The Blue-Book report of our consul, Mr. Gould, gives in certain particulars a most pleasing idea of the condition of the Swiss Republic and its working classes. The Swiss workman is seldom entirely dependent on the actual amount of his wages. He not unfrequently lives in his own cottage, cultivates a small patch of ground with the assistance of his family, and owns a cow or two, or a few goats, which are stall-fed during part of the year, and during the summer graze on mountain pastures, under the charge of a joint-stock herdsman. The peculiar conformation of the soil of a greater part of Switzerland compels, by natural barriers, peasant farming, and affords unlimited rights of summer pasturage. In the canton of Berne, five-sixths of the population hold or have a direct interest in land, and this, Mr. Gould thinks, may be taken as a specimen of the average state of the whole Republic, which contains less inhabitants by about half a million than our metropolis. Two peculiar circumstances assist the Swiss in acquiring freeholds which the natural barriers of a mountainous country divide into small plots. The one is their courageous emigration. Wherever money is to be made, the well-educated Swiss workman is to be found, labouring hard and saving money, with the fixed idea of returning to settle in his own country on the fruits of his savings. The other is the large revenue annually poured into the country by pleasure travellers, who, whether wealthy or not at home, are lavish during their holiday trips. The taste that Rousseau created and Byron stimulated, vulgarized by Albert Smith and intensified by the Alpine Club, has been worth millions to the dwellers in these barren regions. They have known how to make the most of this foreign milch cow. Not only has every inducement been provided to tempt the stranger to come and spend his money in employing the labour, or consuming the produce and the imports of the country, but mendicancy has been organized into an army. It is a very stupid Swiss child that cannot torment summer visitors into bestowing enough to find it clothes and food for the rest of the year. The full benefit is derived from savings brought home from foreign countries and the results of working and begging in the summer season, because the Swiss are a frugal race. Their wages at regular employment are low, their hours of work are long—practically unlimited—but they live on food and are content with clothing which would soon make our working classes very rich in savings. They live chiefly on good bread, cheese not so good, potatoes, vegetables, and fruit; meat they seldom eat more than once a week, and then in very small quantities. Education is compulsory, and the very best education is within the reach of every Swiss within walking distance of a town of any importance. Thirteen and a half per cent. of the total revenue of Switzerland is devoted to popular education. Free libraries are established everywhere; attendance at primary schools is compulsory; there is hardly a village in Switzerland without its choral society, and often its instrumental band; rifle clubs and athletic sports are cultivated; in a word, the Swiss Jack, although dressed in cheap garments and fed on coarse food, has no chance of being "a dull boy." In the little strip of territory comprising the canton of Lucerne, Mr. Gould says, "there are no less than "sixteen principal choral societies, seventeen musical societies, "thirteen theatrical societies, and twenty-five brass brands." Yorkshire, our most musical county, could not equal this. In a word, "Switzerland is probably the country where actual poverty "is less known, and comparative affluence and ease are more "widely diffused through every section of the community." Unfortunately there is a dark side to this picture not mentioned in Mr. Gould's report. Recent accounts, supported by statistics, have shown that the Swiss have ceased to be a sober people—free trade in liquor exists to the utmost extent. The extension of beetroot and potatoe distilleries throughout the Continent has made spirits cheap, and the education, with the manifold amusements of the Swiss, has not protected them from the conquests of intoxication. The subject has become so serious as to attract the attention of the Legislature. We shall be curious to see how this essentially practical question will be solved by these model republicans. It is worth noting that while in several Swiss cantons marriage is restrained, *prostitution regulated*, and a contagious disease law in full force, in no canton have the able-bodied any claim to relief. Assistance is confined to the imbecile, the infant, and very aged population. It is because the two first classes of paupers are increased by the prevalence of intoxication, that the attention of the Swiss Legislature has been drawn to the limitation of alcoholic drinking.

At the mining capital of Truro two gentlemen, both with a reputation as social reformers, are soliciting the votes of the electors. Mr. Jenkins is a barrister, who rests his claims on the authorship of "Ginx's Baby," and his efforts to induce the Government to pay the passages of destitute emigrants. Mr. Augustus Smith is a landed proprietor, the owner of the Scilly Islands, the condition of which he has very much improved by discouraging drinking and smuggling, and encouraging agriculture. He is a liberal and judicious landlord. He has also worried the Government very properly on its claim to the "sea "margins," and was the first to fight a great battle for the now popular cry of "open spaces" with the Earl of Brownlow, on the question of Berkhampstead Common. To this example the movements for preserving Wimbledon and Epping are greatly due. The Berkhampstead contest cost Mr. A. Smith several thousand pounds, including the pay of the army he took down to pull down Lord Brownlow's iron railings. Mr. Jenkins, not having either property or local claims to assist him in a canvass, which if successful may make him an Under-Secretary of State, a colonial or Indian judge, or at any rate a county court judge, has taken a leaf from the book of American stump orators. When the celebrated Henry Clay was canvassing for President, he tried to conciliate the working men by wearing a patched coat. Broadcloth was dearer in those days, and mechanics wore patched coats. Mr. Jenkins has sewn a patch upon his opinions, and tries to secure the votes of the admirers of Mr. Odger by a piece of vague and mischievous claptrap, which he has not the least idea of reducing to any practical shape beyond getting the votes of very ignorant working men. Mr. Jenkins declares that "the working man of England is ground between the land-laws and the power of capital." What does he mean? If he were an honest advocate of Communism, like Mr. Odger, his meaning would be clear; but, as he knows perfectly that to advocate the principle of a general division of property would deprive him of the support of every man who had a freehold cottage, or £50 in the savings bank, he declares, when asked, that he is not a Communist. Again, if he were to say distinctly that he would devote himself to making the transfer of land easy, safe, and cheap—that he would advocate the limitation of entails to lives in being, or their total abolition—we should know what he meant, and he would open subjects well worth discussion. Again, if he were to denounce the truck system of certain manufacturers, on which a Royal Commission has just reported, or any of the overwork imposed on infant and ignorant labour, his meaning would, at any rate, have been intelligible; but he denounces rich men for being rich, as a farmer would denounce rats, and rabbits, and other vermin; and to denounce landowners for having land, to an uneducated audience, is to suggest that the candidate for parliamentary

honours has some patent plan for giving every working man a cottage and a few freehold acres of land, and every mechanic a share in the profits of his employer. As a matter of historical fact, the Legislature has been engaged for the last fifty years in endeavouring to improve the condition of the working man, with a zeal not to be paralleled in any other country. In the first place, there has been a steady progress in the repeal of the taxes on articles of food, clothing, and dwellings, which are paid in every other European country by protective revenue and municipal duties like *octroi*. In England there is no tax on food entering cities. In the next place, a series of laws originated in this country for limiting the hours of labour of women and children; for excluding women from mines; and recently, for regulating the hours of workshops, and for protecting from their parents the unfortunate children employed in brickfields and other out-of-door employments. The laws for securing wholesome lodgings, water, and drainage of towns, although not perfect, are far in advance of any other European state. All these repeals of taxes, increase of local rates, and limitations of the hours of labour, have been done (most properly) at the expense of the capitalist class, which includes the man who has invested £200 as much as that rare animal, the millionaire. Much remains to be done, especially in affording intelligent education to the masses; but, so far from there being any disinclination, there is great zeal on the part of the titled, moneyed, and employing classes represented in Parliament to investigate and redress every grievance. The reports of the Sanitary and Truck Commissions are evidence of this. The capitalist, whom ignorant, half-educated, and dishonest educated men abuse, is the representative of frugal as opposed to profuse expenditure. His capital is the reservoir which in times of trade drought supplies a steady stream of employment. If our skilled mechanics lived like Swiss workmen, and worked for the hours of Prussian workmen, they would very rapidly accumulate capital, either for personal investment, or for co-operations, to be counted every year in tens of thousands. Mr. Odger may be excused when he proposes to bring the land of England back to hand labour; but Mr. Jenkins, a barrister-at-law and author, ought to be ashamed of such wretched expedients for obtaining temporary popularity.

But little can be learnt respecting the utilization of sewage, from the reports (acknowledged to be imperfect) we receive of the proceedings of the committee of the British Association communicated to the recent meeting at Edinburgh. The report, indeed, is so obviously imperfect that we must refrain from commenting upon it. Much of the value which might be derived from the proceedings of the British Association is lost by the want of early and complete reports supplied at a cheap rate. So far as we can gather, the whole question of the utilization of sewage is in a most unsatisfactory state. Irrigation, except in a few favoured localities, is admitted to be a failure, and the causes assigned are various. Dr. Gilbert considers, too, the earth-closet system inadmissible, except in the cases of small villages. The phosphate of alumina process appears to have received a very imperfect notice at the hands of the committee. They seem to have expressed no opinion as to whether phosphate of alumina is or is not a fertilizer—a point on which much or most of the value of the process depends. Sewage can be effectively clarified and (for the time) deodorized by a much cheaper material, and if the phosphate have no fertilizing value, it is only so much waste. But we hesitate to express any opinion on the proceedings of the committee, from which, however, it appears that little of value is likely to be derived until funds are found to pay the personal expenses of the members in prosecuting their inquiries and experiments. The question will be solved independently in time, and we must wait with patience for the result. At the present time, it must be confessed that in many cases very little intelligence is shown in laying out sewage farms, and the final settlement of the question is thereby delayed.

THE COAL COMMISSIONERS REPORT.

THOUGHTFUL people have for many years speculated on the possible exhaustion of our coal-fields, and the condition England would be reduced to in that event. Closer attention was drawn to the subject by Mr. Edward Hull, who published a work "On the Coal-Fields of Great Britain," in 1864. In a subsequent paper published in the *Quarterly Journal of Science*, Mr. Hull, speculating on a maximum production of 100 million tons a year, expressed an opinion that there was sufficient available coal in Great Britain to last for eight centuries.

The subject next attracted the attention of Professor Jevons, who, on the supposition that the increased rate of consumption in the future time would be constant, as in the past twenty years—viz., 3½ per cent. per annum—came to the conclusion that our available coal would be exhausted in 110 years.

This alarming statement at once attracted the notice of political economists and coalowners, and the result was the appointment, in 1866, of a Royal Commission "to investigate the probable quantity of coal contained in the coal-fields of the United Kingdom, and to report on the quantity of such coal which may be reasonably expected to be available for use." We can give the results arrived at by the commissioners in a very short space. They estimate the quantity of coal in ascertained fields, lying within 4000 feet of the surface, the lowest depth at which it can be practically worked, at 90,207 millions of tons. They conjecture that there may also exist at workable depths, under strata not yet explored, other 56,273 millions of tons; making a total of 146,480 millions, which, at the present rate of consumption, would last 1273 years. But the commissioners are rather inclined to believe in a progressive increase in the rate of consumption, which they think may, in 100 years, amount to 415 millions of tons per annum; and if it stopped at that figure, the now estimated coal available for use would represent a consumption of 276 years.

Necessarily these estimates partake more or less of the nature of guesses, and should not receive more attention than they deserve. The facts remain, as stated by Mr. Hull in 1864, that "some of our coal-fields have passed their meridian, and, having "expended their strength, are verging on decay. Others have "attained their maximum, or nearly so; this, indeed, is the case "with the majority." And the result is seen in the market price of coals, which exhibits a continual increase.

To no one is this question of more interest than to gas producers, and we should have been glad if the report had afforded us, for one thing, any information or guess as to the probable extent and duration of our fields of cannel. The volume we now notice, however, is silent on a matter which is of the utmost importance in regard to future gas legislation. Coal which will yield by known processes from 10 to 14 candle gas may be abundant enough for centuries to come, but how long shall we obtain coal that will give from 20 to 30 candle gas. We hoped to find some information on this point in the report on the coal-fields of Scotland; but Mr. Geddes, to whom this portion of the kingdom was assigned, got through his report, as he says, "by "snatches of time, now and then," and found no leisure, we presume, to give a separate estimate of cannel in his summary. The report on the Lancashire and Cheshire fields is equally silent on the subject. It may be that subsequent volumes will give us the information we need, and if the commission do not pretend to have completed their labours, we would press the matter on their attention. But we think it may be taken as certain that the exhaustion of our beds of cannel is rapidly progressing, and that at no distant period the cost will be such as to prevent its use in the manufacture of gas without a considerable advance in the price of gas. Remembering, too, that of other coals the best gas coal is being the most rapidly worked out, it becomes a most urgent question what the quality of our gas supply should be. Every year brings proposals and demands for supplies of rich gas, which, it is quite certain, cannot be maintained for many years longer. Under these circumstances the subject deserves the serious attention of all gas producers. We have no right to speculate on future discoveries; we have to deal with facts as they are known. That a substitute for coal may be found is an empty speculation which no man of science ever indulges; that any considerable economy in the use of coal may be effected by appliances for its consumption is in the highest degree problematical. In the natural course of events coal must continue to rise in price; and the condition of England is such that no man can guess what the price will be in twenty years time. The concluding passages in this report are not encouraging. They offer a gloomy prospect of the future of Great Britain, which might, perhaps, have been drawn in deeper colours with greater truth. They merit earnest consideration, and with them we conclude:—

"Whatever view may be taken of the question of duration of coal, the results will be subject to contingencies which cannot in any degree be foreseen. On the one hand, the rate of consumption may be thrown back to any extent by adverse causes affecting our national prosperity; and, on the other hand, new discoveries and developments in new directions may arise to produce a contrary effect upon the consumption of coal. Every hypothesis must be speculative, but it is certain that if the present rate of increase in the consumption of coal be indefinitely continued, even in an approximate degree, the progress towards exhaustion will be very rapid.

The *absolute* exhaustion of coal is a stage which will probably never be reached. In the natural order of events, the best and most accessible coal is that which it the first to be worked, and nearly all the coal which has hitherto been raised in this country has been taken from the most valuable seams, many of which have in consequence suffered great diminution. Vast deposits of excellent and highly available coal still remain, but a preference will continue to be given to the best and cheapest beds, and as we approach exhaustion the country will, by slow degrees, lose the advantageous position it now enjoys in regard to its coal supply. A time must even be anticipated when it will be more economical to import part of our coal, than to raise the whole of it from our residual coal-beds; and before complete exhaustion is reached the importation of coal will become the rule and not the exception of our practice. Other countries would undoubtedly be in a position to supply our deficiencies, for North America alone possesses tracts of coal-bearing strata, as yet almost untouched, of seventy times the area of our own. But it may well be doubted whether the manufacturing supremacy of this kingdom can be maintained after the importation of coal has become a necessity."

DETAILS OF INCOME, FOR THE YEAR 1870.

ABSTRACT OF DETAILS OF INCOME AND EXPENDITURE, SHOWING THE PROFIT REALIZED.

Name of Company.	Total Gas-Rental.	Common Gas.	Price per 1000 Cubic Feet.	Cannel Gas, at 5s. 5d., 5s. 3d., and 5s. 6d. per 1000 Cubic Feet.	Public Lights, including Lighting and Contracts.	Meter-Rents.	Old Materials.	Products.	Miscellaneous.	Total Income from all Sources.	Total Expenditure on Revenue Account.	Gross Profit.	Capital and Borrowed Moneys.	Gross Profit per Cent. on the Capital and Borrowed Moneys.	Gross Profit per Cent. on the Gas-Rental.
	£ s. d.	£ s. d.	s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.		
Chartered	471,869 7 6	363,016 15 11	3 9	72,874 14 11	35,977 16 8	4,034 18 11	1556 10 0	93,326 15 2	1,589 6 5	572,376 18 0	433,729 3 1	138,647 14 11	2,316,877 0 0	5·98	29·38
Commercial	139,397 17 8	124,071 7 5	4 0	..	15,326 10 3	None chgd.	528 5 3	27,895 10 7	188 17 5	168,010 10 11	117,985 8 1	50,025 2 10	437,230 5 0	11·44	35·88
Equitable	88,960 7 0	67,473 7 3	3 9	10,397 17 6	11,089 2 3	1,661 7 2	205 7 2	19,887 5 7	851 14 0	111,566 0 11	72,899 8 3	38,666 12 8	300,000 0 0	12·88	43·46
Imperial	566,316 7 0	496,996 0 5	3 9	..	69,320 6 7	12,949 2 0	1234 3 5	115,986 10 8	1,365 4 0	697,851 7 1	502,890 5 5	194,961 1 8	2,189,835 0 0	8·90	34·42
Independent	76,892 5 9	70,394 15 8	3 4	..	6,497 10 1	2,453 17 1	350 12 5	22,316 8 9	316 14 1	102,329 18 1	78,645 10 3	23,684 7 10	233,200 0 0	10·15	30·80
London	170,164 4 3	140,112 18 3	3 9	10,739 10 11	19,311 15 1	3,555 7 10	782 7 6	41,193 8 8	2,264 14 4	217,960 2 7	143,731 3 0	74,228 19 7	764,164 0 0	9·71	43·62
Phœnix	199,547 16 5	176,469 6 4	3 9 / 4 0 / 4 3	..	23,078 10 1	3,471 14 5	392 14 11	44,394 0 6	3,181 1 6	250,987 7 9	159,768 12 4	91,218 15 5	943,296 0 0	9·67	45·71
Ratcliff	32,467 18 6	28,536 4 5	4 6	..	3,931 14 1	23 13 3	239 19 2	7,682 0 11	152 17 6	40,566 9 4	27,575 3 3	12,991 6 1	115,670 0 0	11·23	40·01
South Metropolitan	90,984 13 1	78,127 14 8	3 2	..	12,856 18 5	None chgd.	337 4 0	24,577 13 11	1,500 2 1	117,399 13 1	87,535 13 10	29,863 19 3	300,000 0 0	9·95	32·82
Surrey Consumers	66,301 2 9	53,364 10 9	4 0	..	12,936 12 0	4 18 9	59 8 0	15,287 19 0	222 19 7	81,876 8 1	55,170 3 7	26,706 4 6	264,260 0 0	10·10	40·28
Western	142,411 0 7	..	5 6	126,057 4 1	16,353 16 6	3,403 2 11	79 13 6	12,404 12 2	16 5 0	158,314 14 2	106,479 5 8	51,835 8 6	408,284 0 0	12·69	36·39
	2,045,313 0 6	1,598,563 1 1	..	220,069 7 5	226,680 12 0	31,558 2 4	5766 5 4	424,952 5 11	11,649 15 11	2,519,239 10 0	1,786,409 16 9	732,829 13 3	8,272,816 5 0	8·85 Average.	35·83 Average.

DETAILS OF EXPENDITURE ON REVENUE ACCOUNT, FOR THE YEAR 1870.

Name of Company.	Coals, including Carriage and Dues.	Purifying Materials.	Supervision and Labour in Manufacture of Gas.	Ordinary Repair and Maintenance of Premises, Tools, and other Implements.	Rents, Rates, and Taxes.	Salaries.	Collectors Commission.	Stationery, Printing, and General Charges.	Directors.	Auditors.	Expense of Distribution and Ordinary Repairs of Mains and Services.	Restoring and Replacing Meters.	Law and Parliamentary Charges.	Bad Debts and Extraordinary Expenses.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Chartered	259,465 15 8	3,546 1 2	64,565 1 10	27,661 3 7	15,478 5 9	4,847 0 7	5,505 14 0	3,415 17 2	5,565 14 9	302 10 0	24,102 14 1	9,681 2 7	1,739 7 8	7,852 14 3
Commercial	63,247 7 1	1,872 7 4	14,615 4 9	16,175 19 5	3,260 5 6	1,518 0 0	1,352 6 3	1,381 7 7	1,500 0 0	150 0 0	8,313 15 1	2,047 15 0	(6 7 11	2,484 12 2
Equitable	42,934 19 0	812 8 4	8,531 17 5	6,357 6 11	2,978 15 5	1,281 13 0	1,078 1 11	1,424 12 2	1,500 0 0	90 0 0	4,445 4 11	454 12 6	62 14 1	947 2 8
Imperial	281,361 13 3	6,656 7 7	48,786 6 11	76,078 5 11	14,822 18 7	8,414 1 0	8,574 10 4	5,489 17 4	4,000 0 0	157 10 0	31,034 19 6	8,296 5 3	777 9 1	8,440 0 8
Independent	44,562 3 2	778 15 5	11,820 7 0	5,579 14 2	2,873 10 7	1,164 0 0	1,384 13 3	786 17 10	1,500 0 0	100 0 0	5,511 14 3	1,477 3 2	25 17 9	1,080 13 8
London	73,019 12 8	1,190 9 9	19,326 12 6	15,608 11 7	8,056 10 4	1,200 9 11	2,589 2 1	1,023 9 5	1,650 0 0	100 0 0	14,601 13 9	3,111 12 4	181 6 7	2,071 12 1
Phœnix	81,996 16 0	2,172 10 6	20,003 5 2	24,158 18 4	6,368 6 8	1,633 13 0	2,852 2 11	500 16 6	2,000 0 0	100 0 0	11,607 10 2	3,528 6 3	49 8 8	2,796 18 2
Ratcliff	13,372 4 1	227 16 10	4,029 5 4	2,790 12 2	1,084 8 9	651 17 6	322 15 0	267 12 5	800 0 0	31 10 0	3,063 7 3	512 12 10	4 0 10	417 0 3
South Metropolitan	44,284 14 9	1,034 4 0	13,437 10 6	5,444 2 1	3,193 2 11	1,247 10 0	1,252 9 11	1,322 3 4	1,200 0 0	100 0 0	11,512 8 9	1,577 10 2	78 11 7	1,851 5 10
Surrey Consumers	32,167 10 7	719 8 4	6,864 18 7	2,498 6 8	2,684 0 2	994 18 0	644 15 7	741 1 5	1,350 0 0	63 0 0	4,125 4 8	1,164 8 5	540 4 2	612 7 0
Western	67,887 13 4	3,225 7 4	12,451 13 10	3,078 5 9	2,371 17 5	1,855 0 0	1,479 7 7	1,255 4 8	1,500 0 0	120 0 0	8,930 15 8	1,023 7 5	118 8 3	1,182 4 5
	1,004,300 9 7	22,235 16 7	224,432 3 10	185,431 6 7	63,172 2 1	24,808 3 0	27,035 18 9	17,608 19 10	22,565 14 9	1,314 10 0	127,249 8 1	32,874 15 11	3,643 16 7	29,736 11 2

METROPOLIS GAS COMPANIES, 1870.

REVENUE ACCOUNT, *compared with that of* 1869, *showing the Increase or Decrease in each Item.*

	Chartered.*		Commercial.		Equitable.		Imperial.		Independent.		London.		Phœnix.		Ratcliff.		South Metropolitan.		Surrey Consumers.		Western.	
	Inc.	Dec.	Inc.	Dec.	Inc.	Dec.	Inc.	Dec.	Inc.	Dec.	Inc.	Dec.	Inc.	Dec.	Inc.	Dec.	Inc.	Dec.	Inc.	Dec.	Inc.	Dec.
	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£
Total gas-rental	..	13812	4605	..	4423	..	..	6602	2172	..	..	128	750	..	..	1364	821	..	2775	..	14718	—
Common gas	..	9788	4561	..	..	452	..	5800	2091	..	..	939	502	..	..	1170	370	..	2898	..	..	—
Cannel ditto	..	2283	..	..	408	..	..	..	..	..	496	..	..	..	..	..	..	..	..	..	13962	—
Public lights, including lighting and contracts	..	1737	45	..	4467	..	..	802	80	..	314	..	249	..	..	194	451	..	..	124	756	—
Meter-rents	..	105	None	chgd.	15	..	861	..	44	..	932	..	3471	..	16	..	None	chgd.	4	..	246	—
Old materials	171	..	342	..	111	..	1234	..	127	..	69	..	392	..	209	..	172	..	..	151	..	3
Products	7831	..	4135	..	3736	..	22839	..	3738	..	4309	..	291	..	574	..	1944	..	535	..	534	—
Miscellaneous	184	..	..	70	125	..	..	286	9	..	526	..	..	60	40	..	195	..	..	6	7	—
Total income from all sources	..	5726	9013	..	8409	..	18045	..	6090	..	5707	..	4845	..	..	523	3131	..	3158	..	15502	—
Ditto expenditure on revenue account	..	3924	11935	..	8482	..	54365	..	3268	..	3911	..	5188	..	..	3746	4547	..	1890	..	5985	—
Gross profit	..	1802	..	2922	..	73	..	36319	2823	..	9618	..	..	343	3223	..	..	1416	1269	..	9518	—
Capital and borrowed moneys	296841	..	..	..	..	..	106114	..	..	2600	..	5857	..	..	..	..	30277	..	..	1700	3554	—
Gross profit per cent. on capital, &c.	..	0·97	..	0·67	..	0·03	..	2·19	1·31	..	1·32	..	..	0·04	2·79	..	..	1·64	0·54	..	2·24	—
Ditto ditto on the gas-rental	0·47	..	..	3·40	..	2·36	..	5·94	2·88	..	5·68	..	..	0·35	11·14	..	..	1·87	0·24	..	3·25	—

METROPOLIS GAS COMPANIES, 1870.

EXPENDITURE, *compared with that of* 1869, *showing the Increase or Decrease in each Item.*

	Chartered.*		Commercial.		Equitable.		Imperial.		Independent.		London.		Phœnix.		Ratcliff.		South Metropolitan.		Surrey Consumers.		Western.	
	Inc.	Dec.	Inc.	Dec.	Inc.	Dec.	Inc.	Dec.	Inc.	Dec.	Inc.	Dec.	Inc.	Dec.	Inc.	Dec.	Inc.	Dec.	Inc.	Dec.	Inc.	Dec.
	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£
Coals, including carriage and dues	19476	..	1688	..	5458	..	14220	..	2749	..	..	2226	52	..	..	344	1490	..	947	..	3476	—
Purifying materials	..	1890	..	244	171	..	1237	..	..	120	41	..	237	..	..	91	25	..	..	138	..	73
Supervision, labour, &c.	1707	..	..	338	898	..	1449	..	302	..	777	..	680	..	..	618	..	760	554	..	199	—
Repair and maintenance of premises, tools, &c.	2491	..	11119	..	911	..	30538	..	607	..	..	5288	4120	..	..	3973	1055	..	..	749	..	3761
Rents, rates, and taxes	..	2304	..	146	741	..	167	..	..	59	1414	..	..	1206	80	..	..	88	..	238	423	—
Salaries	..	1540	199	..	118	..	..	494	143	..	142	..	263	..	28	..	..	153	198	..	159	—
Collectors commission	..	203	..	8	..	..	140	..	19	..	130	..	143	..	..	12	6	..	6	..	78	—
Stationery, printing, and general charges	..	1432	17	..	506	..	839	..	20	..	..	555	..	47	..	3	154	..	144	..	163	—
Directors	39	..	..	..	200	..	750	..	159	..	150	..	..	..	..	..	..	..	..	..	250	—
Auditors	..	136	..	..	..	..	..	..	..	..	..	..	..	..	8	..	..	..	..	..	..	—
Distribution and repair of mains and services	..	3176	184	..	11	..	2274	..	68	..	3784	..	706	..	1169	..	2179	..	362	..	2873	—
Restoring and replacing meters	..	2194	..	194	..	328	493	..	..	126	..	790	634	..	481	..	213	..	256	..	204	—
Law and parliamentary charges	..	1135	..	189	..	1	302	..	..	384	107	..	..	272	4	..	..	12	515	..	118	—
Bad debts and extraordinary expenses	..	13628	117	..	..	263	2346	..	228	..	..	1597	..	19	..	314	440	..	34	..	..	125

* Amalgamated with the City of London and Great Central Companies.

Circular to Gas Companies.

Our readers will find in another place an abstract of the accounts of the metropolitan gas companies for the year 1870, which we are glad to see indicate continued prosperity. It will be seen that there is a slight decrease in the total gross profit, as compared with the previous year—the amount in 1870 being £732,829, and in 1869, £749,254—the difference appearing exceedingly small when we remember the reduction in price of 3d. per 1000 feet, made by the Chartered, Equitable, Imperial, London, and Phœnix Companies, and of 6d. by the Western Company. Notwithstanding the reduction in price by the last-named company, the accounts show an increase in total gas-rental to the amount of £14,718, which, under the circumstances, is noteworthy. The decrease in the cases of the Imperial and London Companies is easily explicable, but that of the Ratcliff Company is not so easily accounted for. The total gas-rental of all the companies now amounts to £2,045,313, and the total paid-up capital and borrowed moneys to £8,272,816. The total increase in gas-rental of only £8361 9s. 1d. would appear insignificant, but for the reasons we have given above; as it is, however, it looks highly satisfactory, as showing a large increase in consumption. The quantity of common and cannel coal consumed in the year reached the enormous amount of 1,225,839 tons, the cost of which, including the delivery into store, was £1,004,300, or 16s. 4½d. per ton. The total quantity of gas supplied to private consumers was 9,122,113,853 cubic feet. This is exclusive of the gas supplied to public lamps and under contract, of which we have no estimate of the quantity consumed, but which produced a rental of £226,680. It is probable that the quantity so supplied was not less than 1,500,000,000 cubic feet, which would make the total supply of the metropolitan companies over 10,622 million cubic feet, a total which must excite the wonder of every one who attempts to form a conception of the bulk, and remembers the regularity with which the supply is made. It may be noted that the consumption of gas in London is just about double that in Paris.

The Phœnix Company keeps the lead in making the highest profit on gas-rental, the several companies, in this respect, standing in the following order:—

Phœnix	45·71	per cent.
London	43·62	,,
Equitable	43·46	,,
Surrey Consumers	40·28	,,
Ratcliff	40·01	,,
Western	36·39	,,
Commercial	35·88	,,
Imperial	34·42	,,
South Metropolitan	32·82	,,
Independent	30·80	,,
Chartered	29·38	,,

In the item "Bad debts and extraordinary expenses" we are glad to notice a large decrease, as compared with the previous year. Under this heading come the expenses and remuneration of the referees and the salaries of the chief gas examiner and official auditor, which are distributed among the companies as follows:—

Chartered	£2314	7	11
Imperial	3448	10	0
South Metropolitan	617	4	5
Total	£6379	16	4

It is satisfactory to notice again this year a considerable decrease under the head of "Law and parliamentary charges." One of the most gratifying features shown in the abstract is the large increase in the sum derived from products. This is shared in by all the companies, the accounts of every one exhibiting an increase in this item.

The decreased cost of purifying materials to the Chartered Company shows one advantage the company derive from the works at Beckton. Last year the cost of these materials was only £3546, as against £5435, the cost to the united companies the year before, and this with a very large increase in the amount of coal carbonized.

The capital accounts of three of the companies have been slightly diminished by the repayment of borrowed moneys, but the accounts do not disclose the source from which the funds have been derived.

Such are the chief features in these accounts, which exhibit the gas industry of the metropolis in a highly satisfactory and prosperous state.

It will be interesting to see, in connexion with the above, the principal items in the accounts of the Paris Gas Company for the same year, which we have now before us complete. The quantity of gas delivered by the company for consumption in 1870 was 4,042,980,818 cubic feet; that is, 1,085,027,238 cubic feet less than the quantity distributed in the previous year. The total gas-rental of the company for 1870 amounted to £1,095,216 12s. 4d., which is less than the rental of 1869 by £345,505 1s. 1d. The cost of the coal distilled was £372,265 16s. 11d., and the expenses of purification £6524 2s. 10d. These amounts look exceedingly small for the quantity of gas produced. The forms in which the accounts of the Paris Company are kept prevent us from giving a comparative statement under all the headings in our abstract of the metropolitan accounts, but we may mention that the sale of tar and ammoniacal liquor produced for the company £34,877, and the sale of coke, after deducting that used as fuel, realized £216,856. The scarcity of other fuel during the siege extended the sale of this combustible among classes who had not before employed it; and the directors, as a consequence, anticipate an increased demand in the future. Notwithstanding the difficulties the company had to contend with, and the almost total cessation of the manufacture of gas for three months, the gross profit made by the company on the year's working amounted to no less a sum than £606,652 18s. 8d. The divisible profits added to the amount carried forward in previous years makes a total of £563,858 7s. 3d., out of which a dividend for the year is paid of £1 18s. 4d. per share, which is equal to 19 per cent. on an original share. Altogether, then, we may heartily congratulate the company on the results achieved in a period of extraordinary difficulty and disaster.

The city of Lyons recently had a narrow escape of being left in total darkness by a sudden strike on the part of the men in the gas-works. By the energy, however, of the directors and officials, sufficient assistance was found to keep the retorts in action, and the strike seems to have completely failed in obtaining the object, which was an advance in wages of one franc a day.

A paper, published by Mr. S. Elster, of Berlin, contains some remarks which seem worthy of attention. They point to the necessity (already recognized) of regulating the access of air to the inner surface of the flame of an Argand burner. This is now done in all good burners by contracting or widening the ring of the burner, according to the quality of the gas to be consumed. But in such cases the opening is invariable, and the burner is only fitted for gas of one quality. Elster's idea is a moveable shutter of fine slits, by which the access of air can be regulated until the maximum of illumination is obtained. When, he says, the access of air to the inner surface of an Argand flame is completely prevented, the gas burns with a conical-shaped smoky flame; when air is admitted by degrees, the illuminating power first increases, and then gradually vanishes, until at last the blue light of burning carbonic oxide only remains. By regulating the supply of air, however, a flame resembling in colour that given by olefiant gas, and showing a maximum of light, can be obtained, which is strictly comparable with that given by a candle, the flame of which is perfectly similar in colour. There is here, as we have said, an idea which may deserve the notice of test-burner makers.

Correspondence.

THE GAS REFEREES REPORT ON AMMONIA IN GAS.

Sir,—In the referees report on ammonia, containing as it does so much valuable information, there are one or two points that appear to me to need a word or two of explanation, which, with your permission, I will endeavour to give.

In the description of my scrubber, it is stated that "the open area or interstitial spaces in this scrubber are on the average three times greater than the area of the pipes which lead into and out of it." Fifty times greater would be much nearer the truth.

It is further stated that "the weak point of this scrubber is that it cannot eliminate the tarry vapour from the gas so well as the coke scrubber."

This, certainly, as far as I know, has not been proved; in fact, my experience is quite in the opposite direction. I have during the last twelve months passed the gas, after leaving the condenser, through a vessel of large area, the interior being perfectly open; the gas is thus brought nearly to a state of rest, and the tarry vapour which previously had been carried forward by the rapid current of the gas has now an opportunity of falling, the result being that much less tar now reaches the exhauster than ever before.

The statement that a scrubber of this kind was first adopted at the Haggerston works of the Imperial Company is a mistake. I fitted up the first at the South Metropolitan works in 1866, while that at the Imperial was done last year.

Mr. F. C. Hills, of Deptford, originally introduced the coke scrubber to the South Metropolitan works, and from the first the coke has always been arranged in separate tiers, with an open space between each. I do the same with the system of thin boards.

I was led to adopt this plan from a desire to avoid the expenses and inconveniences resulting from the use of coke. I sought and have found a means of exposing the gas to an immense area of wetted surface without resistance or possibility of choking. In a vessel 15 feet 6 inches diameter, fitted with about 21 tiers of 11-inch

boards, there is a superficial area of upwards of 100,000 square feet, or considerably more than two acres.

I am free to speak in favour of my scrubber, because I am not and never have been in any way pecuniarily interested in its manufacture. Possibly I have found a scrubber fitted with boards more effective in removing ammonia than one charged with coke, both working under similar conditions. My scrubber does not in any way come into competition with Mr. Mann's system, for mine relates only to the interior filling, while his claim is for the even and constant distribution of the water, which I, being compelled to use a common Barker's mill, cannot effect so satisfactorily.

I thank you for granting so much of your space, and wish that gasmen would more largely use your JOURNAL as a means of discussing matters connected with the manufacture of gas.

GEORGE LIVESEY, *Engineer.*

South Metropolitan Gas-Works,
Sept. 7, 1871.

Legal Intelligence.

YORK POLICE COURT.—GUILDHALL, MONDAY, AUG. 28.
(*Before* D. HILL, *Esq.*, *Dr.* SHANN, *and* W. D. HUSBAND, *Esq.*)

TAMPERING WITH PIPES OF THE GAS COMPANY.

James Kidd, tinner and ironmonger, Layerthorpe, was charged with having fraudulently altered and tampered with the pipes of the gas company, with a view of consuming gas without its passing through the meter.

Mr. COBB appeared for the company, and Mr. T. G. MANN for the defendant.

The company having some suspicion with regard to the defendant, the meter inspector had been put on his guard. On the 12th of August, Richard Dalton, an inspector and gas-fitter, called at the defendant's premises, when he found that the inlet and the outlet pipe had been disconnected from the meter, and a temporary pipe fixed so as to prevent the gas passing through it. On being spoken to, he stated that he did not know how it had been done, and he took away the temporary pipe. Dalton and Mr. Sellers, the clerk, afterwards saw the defendant, who said that he had only put it on the previous night for about five minutes, as the gas would not go through the meter. Mr. Sellers told him that was all rubbish, because if he had only wanted a light for that short time he might have lighted a candle. The defendant then said that the gas was not burning more than a quarter of an hour at the most. On a pipe being connected with the meter it was found to work all right. During the interval, however, he said he knew he had done wrong, and he was very sorry for it. He also said he would pay anything, or beg pardon, rather than that the case should be reported.

It was submitted, in defence, that Mr. Kidd had no fraudulent intention, and that a small penalty would suffice.

Defendant was fined £5 and costs.

Parliamentary Intelligence.

HOUSE OF COMMONS.
(*Before Viscount* BURY, *Chairman; Mr.* WATERHOUSE, *Colonel* STUART, *and Sir* JAMES STRONG.)

EDINBURGH AND DISTRICT WATER BILL.
(*Continued from page* 653.)

THURSDAY, MAY 4.

Mr. *D. S. Moncrieff*, examined by Mr. RODWELL.

I am a writer to the signet, and a representative of the Town Council for the George Square Ward, which contains 15,000 inhabitants. My constituents are generally opposed to this bill, and I hold a memorial signed by several electors against it. I suggested to Bailie Lewis that the opinions of the wards should be taken at a ward meeting. He said the wards were in favour of the bill, but I told him that was contrary to my experience. There is a memorial also from St. Leonard's Ward, which is represented by Bailie Lewis. I attribute the dearth of water to the exceedingly dry seasons we have had lately, and to some extent to a deficiency of appliances among the poor. I have fished St. Mary's Loch. It contains a good deal of soft mud on one side.

Cross-examined by Mr. POPE: The firm of which I am a member are Messrs. Scott's ordinary agents. I object to the St. Mary's Loch on account of the expense and of the manner in which the scheme has been promoted. We knew of the scheme in 1868. There is trout-fishing in St. Mary's Loch.

Mr. *B. F. Dun*, examined by Mr. WILL.

I have resided in Edinburgh for a considerable period. Having retired from my former occupation in the Inland Revenue, I devote my time exclusively to questions having reference to the interests of the working classes. From the great intimacy I enjoy and the intercourse I have with the shopkeeping and working classes, I have great opportunities and facilities for knowing the opinions of the working and middle classes, and the working classes of Edinburgh are decidedly opposed to the proposal to draw an additional supply of water for the town from St. Mary's Loch. They object principally on account of the cost of the scheme, and because they have not been consulted as to its adoption. They believe that by the use of additional storeage, with checks upon the waste of the present sources, and a rectification of the internal arrangements of the inhabitants by the owners, a greater supply might be obtained from the Pentland Hills.

Mr. *J. D. Wormald*, examined by Mr. WILL.

I am a writer to the signet, and a member of the Town Council. The ward meetings called in 1869 did not properly represent the general feeling. Sufficient notices of them were not given. There was not sufficient information given to the Town Council of the engineers reports, &c. Mr. Leslie's report of the 7th of October, 1870, was not published till the 27th of October—the day after all the ward meetings had been held, and on the very last day on which the town councillors could be nominated. I never saw Mr. Leslie's report pointing to other schemes nearer Edinburgh, which could be executed at less cost, until I saw it in this room. We had a three days debate on the question in October. We made repeated applications to have Mr. Leslie's report produced to the meeting, but it was positively refused by the city clerk for the promoters. The result of voting following the debate was 21 to 19. In that debate we made a specific application to the promoters to call ward meetings. We proposed voting-papers, so as to take the opinion of the citizens. This request was refused. In my opinion the community have been completely blindfolded.

By the COMMITTEE: The ward meetings are held at different dates. They are always held about the latter part of October, previous to the first Tuesday in November; but they were all over this year by the 25th of October. The Town Council did not get a copy of the committee's report till three weeks afterwards. I throw the responsibility on the Works Committee of the Water Trust, of which Bailie Lewis is convener. After the bill was lodged, a strong feeling arose in the community against it being proceeded with. It was lodged on the 21st of December, but we did not get a copy of it before the 11th of January. I was present at a numerously attended and influential meeting at Queen's Street Hall, which unanimously condemned the scheme. I uphold strongly the fundamental principle that, in all questions affecting taxation, the citizens have a right to be fairly consulted; and, apart altogether from the merits of the St. Mary's Loch scheme, we hold that that has not been done. But we object to this scheme because of the cost, involving, as it does, a present expenditure of money to the extent of £200,000 or £300,000 more than is necessary, in order to bring in an abundant supply for the next generation. It is throwing money away—sinking it in the deep sea, and it can never be got back again. We also hold that the water is not of the best quality. Personally, I do not attach much importance to that part of the question; but, from my own personal experience, I prefer our present supply to St. Mary's Loch water. Another ground of objection is, that we have got so many different sources of supply within half the distance of St. Mary's Loch. We have a choice of three or four sources, where better water can be had. This feeling is almost universally entertained. I have had a difficulty in finding anybody who does not entertain that feeling, except the members of the Water Trust. Last April, in conjunction with Bailie Miller, I visited a great many houses, selecting those of the highest elevation, and we found they were universally well supplied. I believe an additional supply to be necessary in order to meet the wants of dry seasons, but not such a gigantic supply as the promoters are suggesting.

Cross-examined by Mr. CALVERT: The meeting I referred to was simply one of parties opposed to the scheme. The scheme was partly known in 1868. It was discussed at a St. Leonard's ward meeting. I think that the part of Moorfoot which is not occupied for the benefit of Musselburgh is sufficient for Edinburgh for the next 20 years. My plan is to increase our present supply from our present source. I am not aware that the best part of the ground of the South Esk has been occupied for the benefit of Musselburgh; but, if that were so, we have the Heriot to fall back upon. I am aware that the Heriot district is the feeder of the river Gala, and that the people of Galashiels are dependent upon the floods for the very existence of the town. It is very likely the Galashiels people would oppose any scheme to take their water away. The St. Mary's Loch water is not so good as our present supply. I had some conversation with Dr. Macadam on the occasion of my visit to St. Mary's Loch. I expressed an opinion on that occasion that the water was cool, and that, so far as one could judge, it was not a bad water. I did not say, "The water is first-rate." We never had complete information respecting the cost of the scheme laid before us. The detailed account of expense published in the *Scotsman* on the 26th of October, 1869, was official as far as it went.

Thomas Hawksley, Esq., examined by Mr. RODWELL.

I am a civil engineer, and have had great experience in connexion with water supplies in this and other countries. My attention has been directed to the present water supply of Edinburgh, and the sources from which further supplies might be obtained. I have been acquainted with the Edinburgh supply since the year 1830, and have been over the ground many times. The present supply is got from the Pentland Hills and the Glencorse Valley. There is a considerable waste. I have ascertained it from Mr. Ramsay's returns, and also from knowing the comparatively small amount of storeage which there is for so large a drainage acre. The watershed of the Pentlands above the 800 feet level, which is the limit of profitable cultivation in this country, is 36,000 and odd acres. This ground is capable of producing, not on an average, but on an average of three consecutive dry years, no less than 45 million gallons per diem, of which, supposing it were all to be utilized—and that quantity would be wholly unnecessary for a place of so comparatively small a size as Edinburgh—if the whole of that quantity were used, one-third would be the proper apportionment to the mills, being 15 million, and leaving 30 million available for the supply of Edinburgh. No such quantity, however, is, or ever could be, required for Edinburgh. The present waste at the weirs has been proved by Mr. Ramsay to be 4,154,354 gallons per day; that is to say, it is some 16 gallons per head per diem upon the whole of the existing supply. If ordinary care were used in Edinburgh with regard to the waste, there would be no necessity for having any further supply for many years to come. The present average supply is about 9 million gallons per diem, and that, for want of storeage room, descends in certain seasons to about 7 million gallons per diem. Now, taking the largest possible supply that a place like Edinburgh could use, and allowing for a large amount of waste—taking, for example, 25 gallons per head, leaving a little over 20 gallons per head in winter, and about 30 gallons per head in summer, the greatest quantity that could be used would be 6½ million gallons per diem. I am now speaking of a great excess being allowed for what I may call irrepressible waste; but the waste in Edinburgh is now to a very great extent repressible. I know it myself, because I have examined the houses, and looked at the apparatus, and know the way in which things are managed, or rather not managed at all. Great loss arises from insufficiency of storeage at the fountain head, but in the town it is absolutely ruinous waste. I never in my life saw so bad a district in this respect. It is worse than Glasgow, because in Glasgow, as a rule, they carry up the water to the top of the house, and then bring it downwards; but in Edinburgh it goes sometimes up and sometimes down, and sometimes it is throttled at the entrance to the service-pipe, and altogether the system is such as to enable the man living in the bottom part of the house, by the misuse of the very bad appliances at his disposal, to prevent all the people above him from getting any supply. That is actually the cause of the complaints of the want of water in Edinburgh. I have had occasion to remedy the same state of things in different places. Take Norwich, for example. The works at Norwich were purchased some time ago by a new company. They were bound by the Act of Parliament to give a constant supply. They attempted to do so, but failed; but the reason was this, that the fittings were in so bad a state that the water was being continually run away, exactly in the same way that it is run away at Edinburgh. The company then applied for an Act of Parliament to enable them to put the fittings right. The Act was opposed, but fortunately passed. The fittings were set right, and the result was that the consumption of water descended from 40 gallons to 14 gallons, and it was kept on constantly, day and night, so that the whole town could draw water whenever they liked; whereas, formerly the company were unable to keep it on during the night. That state of things has continued till the present day, and perfect satisfaction is given to the community, whilst the company is prospering. If it were necessary at Edinburgh, I think a sufficient supply could be obtained easily from the Pentlands, and there is an amphitheatre of hills near Edinburgh that would supply much more.

By the CHAIRMAN: The supply from these hills may be anything, from the proper quantity of 25 gallons to the improper quantity of 150 gallons per head; but of course such a quantity as that, or anything approaching to it, would be absurd.

By Mr. RODWELL: What should be done is this: First stop the waste. Then, supposing Edinburgh, from increase of population, or any other cause, came to require more water, all that would have to be done would be, from one ten years to another, to utilize a little more water of the Pentlands, and by that means Edinburgh could have all the water it wanted, and that too of a very good quality.

By the CHAIRMAN: I am not speaking now of the 36,000 acres. Then there are upwards of 6000 acres left at Moorfoot. The committee, a few days ago, I understand, gave power to Musselburgh and Dalkeith to take a supply of water from the South Esk. The quantity utilized for that purpose will be about 900 acres; but there are 7500, and, of course, the remaining portion may from time to time be utilized. The 140 or 150 gallons would be got by taking in

the South Esk as well. About 120 would come from the Pentlands, after giving the usual proportion of compensation.

By Mr. RODWELL: That supply would be secured by a system of reservoirs, which may be constructed from time to time, if it were conceivable that such a quantity should be ever wanted; but it is inconceivable. To construct reservoirs, which would give the people of Edinburgh altogether so nearly like 50 gallons per head per day, would only require about £100,000. There would be no difficulty in making reservoirs, as there are several situations well adapted for that purpose. An advantage of having the water in the reservoirs at the Pentlands would be that they would be in immediate communication with the present works.

Cross-examined by Mr. CALVERT: The present water-works do not cover an area of 14,000 acres. There is no boundary; but it is only a portion of 14,000 acres they cover, and for this reason, that it was the habit of the old water company to resort to springs, and therefore they had a number of works traversing the district marked on the map, but not by any means using all the water. The great bulk of the water runs to waste. Not more than half of it is used either for compensation or for supplying the city.

Mr. CALVERT: Are you not aware that all the streams to the east of the pink mark on the map are already appropriated by the millowners?

Witness: Most of the streams in the neighbourhood of large towns are appropriated by the millowners. In my statement I have considered compensation. I have also taken into account a large reservoir belonging to the paper makers in the middle of the supply mentioned, also the probable extent of the area which they could utilize; and I found that if one-third of the whole was apportioned to them, it would be under the circumstances a very ample compensation; but that as the district yields in three consecutive dry years 45 million gallons, a very much larger quantity than a third could be given to them without injuring the supply of Edinburgh.

Mr. CALVERT: The first thing you would have to do would be to buy up the millowners?

Witness: Certainly not. Why, I have to deal with streams on which there are 40 mills, and we never buy up any of them. We simply utilize the water that goes to the sea.

Mr. CALVERT: Then you mean to tell the committee that these 36,000 acres will yield the quantity of water you name in addition to the compensation?

Witness: I have told the committee that the whole yield will be 45 million gallons, and I give that as a positive fact within my knowledge. No such quantity could possibly be wanted for Edinburgh and the mills together, but I was asked what was the productiveness of the district, and I was bound to answer the question. Not half of it can ever be wanted. I include only an insignificant proportion of cultivated land in these 36,000 acres, but I cannot state the exact quantity, as I have never taken out the small patches above 800 feet. I should never think of doing such a thing, but I have gone over the ground and examined it. In this climate wheat and other cereal crops, except oats, will not grow at above 800 feet.

Mr. CALVERT: What part of the district is not appropriated at present?

Witness: All the portion from which water runs without coming up as springs, or being impounded in the very few reservoirs there now are—about half is utilized. The rainfall of the district is almost exactly, but rather over, 20 inches available. The average rainfall is somewhere about 38 or 39 inches, taking the hills into account. The actual rainfall is not 25 inches. Your rain-gauges undoubtedly give that mean, but these gauges do not represent the fall on the district, because they are all, or all but one, on levels below where the fall is greatest, and no allowance has been made for this. Then there is another error. No water engineer ever pretends to make water-works on the footing of the supply given in the year of the greatest drought. The office of a reservoir is to equalize this supply. The reservoir is filled in a period of redundant rain, and then the contents of the reservoir are taken into account in addition to the rainfall of the drier year. We ascertain the average over the whole district, we then deduct from that average one-sixth of the whole quantity, which brings us to the quantity which can be utilized upon a succession of three consecutive dry years. From that quantity we deduct the loss by evaporation, and the remainder is divided by the proper number of days storeage, which is much larger, and therefore the divisor is larger, and gives a smaller result than what has been spoken of in this committee. The quotient is the quantity which can safely be relied on for the supply of the town. You may take any long rain table you like up to 20 or 30 years, so as to bring in all the dry years, and you will find that the three consecutive dry years are just one-sixth below the mean within a fraction of an inch. All these gauges are at a level of at least 800 feet, but these hills go up double that height. The present watershed of 14,500 acres will yield nearly 19 million gallons a day. If you give a third of that to the millowners there would be 12 million gallons left for the supply of Edinburgh. As a rule, the cost for additional storeage is £60,000 for 1 million gallons per day. The scheme which is at present before the committee will have the effect of putting a first mortgage of £30 upon every family in Edinburgh.

FRIDAY, MAY 5.

Thomas Hawksley, Esq., further cross-examined by Mr. CALVERT.

The Glencorse Valley contains 3428 acres. What the North Esk contains I cannot say, because it is not included in the Edinburgh water scheme; but it is a small area. The water of the valley of the Glencorse Burn and the North Esk River are the parts of the Pentlands mentioned in the petition. There are in the Pentlands extensive sources of water not included in the Glencorse burn and the North Esk River. The Lyne itself contains 6000 or 7000 more acres. I do not know how many reservoirs will be required to utilize the water of the 36,000 acres. It is not a question of the number but of the capacity of the reservoirs. I have never suggested that the 36,000 acres should be utilized; on the contrary, I say there are 36,000 acres, and it would be a perfect absurdity to suppose that that number of acres would be required for the supply of Edinburgh. If you wish me to deal with the scheme, I can do so; but I am only giving general evidence, and I can tell you there are plenty of sites for utilizing more water than would supply Edinburgh at 50 gallons a head per diem. Altogether there are sites which I know would contain an addition to the existing storeage of some 7000 or 8000 million gallons. The suitable sites for the supply of Edinburgh for many years to come would be in the Glencorse Valley. There are two excellent sites there, quite unappropriated, above the present reservoir; and then by extending catch-water drains in the usual way, you can bring in any necessary quantity of water. I could make, at least, eight reservoirs in excellent situations, in addition to the nine that already exist. There are plenty of situations on the Pentlands and the brooks flowing therefrom. I cannot tell the expense, because these reservoirs would only be required for an impossible quantity. It is exceedingly difficult to say what has been the compensation in the streams in this district up to the present time, because it has been done by reservoirs, and not by specific quantities.

Mr. CALVERT: Taking 20 inches as the available rainfall, has the compensation been hitherto 8¾ inches?

Witness: I cannot tell you, but it is very possible; certainly not upon 36,000 acres. I think there has been some error as to the average upon which that is calculated. I am not aware that the water company rejected the Pentlands in 1868. I know they did not; but they had a scheme, on the recommendation of Mr. Leslie, for utilizing the Moorfoot water, and that was a very excellent and a very cheap scheme indeed, which I concurred in entirely. I believe I made a report to the directors, but I do not remember anything about it. [Report handed in.]

Mr. CALVERT: You gave us yesterday the overflow of the Glencorse waste weir.

Witness: No; a paper was put in my hands, and I was asked some questions with respect to it. I know nothing of the details, of course.

Mr. CALVERT: I think you said that out of any quantity of water coming from a distance, one-sixth must be deducted as waste unavoidable.

Witness: One-sixth of the average rainfall, in order to reduce it to the quantity which can be relied upon during three consecutive dry years.

Mr. CALVERT: Here you give us the quantity of water flowing over the weir at 4 million odd gallons. I believe that is much less than one-sixth of the water collected in Glencorse.

Witness: I am sure I do not know; but I know that reservoirs can be made in that valley which will produce 4 million gallons a day, in addition to what they have now, but I know nothing about that calculation of Mr. Ramsay's. In 1866 I drew up a scheme for obtaining an additional supply for Sheffield. I do not remember the proportion of water per head I proposed to give, but it was probably 25 gallons. The scheme would certainly not give 125 gallons. The case of Sheffield is on a par with what I told the committee about the Pentlands. There are 36,000 acres in the Pentlands, but I do not suggest that 36,000 acres should be used. There were 32,000 acres at Sheffield, and I did not suggest that 32,000 acres should be used, but only as much as was necessary.

Mr. CALVERT: Do you know the number of gallons per head in the scheme as sanctioned by Parliament for Sheffield?

Witness: I believed they reduced the area from 32,000 to 22,000.

The CHAIRMAN: Is it the ordinary course in preparing plans for Parliament to make the scheme larger than you require, leaving it to the committee to cut it down?

Witness: In many cases it is.

Mr. CALVERT: What is the difference between a small and a large gauge in ascertaining the quantity of water?

Witness: A large gauge, if properly placed, and not in a windy situation, always represents the rainfall more accurately than a small gauge can do. Any slant currents or small deflexions about the place carry the water away from the small gauge.

Re-examined by Mr. RODWELL: I object not only to the size of the gauges, but also to the localities in which they are placed, and the effect of wind and weather upon them. The consumption now at Sheffield is between 26 and 27 gallons per head per diem. Some years ago the supply was 40 gallons, but we got rules and regulations made and approved for correcting the fittings and preventing waste. We have already saved 13 gallons per head per diem, and we are only on the threshold of our measures, for, on the completion of our arrangements, we shall get 20 gallons per head saved. I could name 20 towns where, by the prevention of waste, the supply is kept below 20 gallons per day. The capability of the Pentlands is practically unlimited. The North Esk reservoir is put up quite high in the mountains, and has a very small drainage area above it, and does not utilize, as a town would with a regular draught, the whole of the water even of that drainage area.

By the CHAIRMAN: My report was made under the circumstances of the company being the promoters of a bill in Parliament for an additional supply, and having deposited plans which had been prepared by Mr. Leslie for utilizing a part of the South Esk drainage area, giving compensation out of the Fullerton burn. After deducting 15 million gallons for compensation, the supply from the Pentlands would give 120 gallons per head net. I would construct for £100,000 sufficient reservoirs there for supplying Edinburgh with 50 gallons per head per day.

By the COMMITTEE: The present supply is much more than 28 gallons per head. The way in which they reckon 28 gallons is by taking the supply during a particularly dry year, without adding to that supply the quantity of water which could be stored upon the watershed. There is no difficulty, by good management of the present supply, in obtaining (and it generally is obtained) 9 million gallons per diem, and then, by these additional reservoirs, about 4 million gallons more can be stored. That would be an aggregate of 13 million gallons, at a cost of £100,000 more than the present cost. In estimating this large supply, I do not take into consideration any saving of the water in Edinburgh. If they would save the water, there is nothing wanted now, for I would pledge myself to bring the works into such a state of efficiency for about £80,000 that they would be able to supply, on the average, 25 gallons per head per diem, and that every person in Edinburgh should be able to draw water at any time he wanted it, and in any quantity he wanted it. If you had had the two large reservoirs which you really want, the escape over the weirs in 1868 and 1869 would have been bottled up; so that, instead of being 44 million gallons short, you would have had a great redundancy of water. That is obvious on the face of the figures.

The CHAIRMAN: We were told of two reservoirs being empty during the course of one year that was mentioned. Can you account for their being emty?

Witness: Yes. There are two things which contributed to the emptying of them; first of all, it was a very dry year, so that a very small quantity of water came in. Then the draught out of them was enormous in consequence of the unchecked waste. If there had been a larger reservoir, or more reservoirs, to have held the water of the wet years, to be brought in aid of the dry year, and if, at the other end, the waste had been prudently checked, there would have been far more water, without any additional powers being granted by Parliament, than Edinburgh could possibly want.

James Glaisher, Esq., F.R.S., examined by Mr. RODWELL.

I have been engaged in meteorological observations for forty years, and I have given special attention to the subject of rainfall all over the kingdom. I have been in the habit for many years of visiting different districts in order to examine the accuracy of rain-gauges, and I have been over the Pentland Hills at different times. I was there last month. So far as I saw, it is essentially a pastoral country. There is very little arable land indeed. I visited the North Esk reservoirs and saw the gauge. It was impossible to represent the rainfall with the 3 inch gauges then in use. There were two gauges on the spot; one was placed there by Mr. Stevenson, the engineer who built the reservoir. He was with me at the time; and we were told that gauge had not been used for many years, but that a small gauge of 3 inches in diameter had been used in its place. I examined the gauge, and it was furnished with a strap or rod in the centre of it, and having a certain amount of support with regard to the area in which the rain would fall. But it was impossible with a gauge of 3 inches in diameter, in that exposed position, to approach the truth. A gauge of that kind is all right when the rain is vertical, but the greater the inclination of rain the greater the difficulty of ascertaining accurately the rainfall with a small gauge. The available gathering-ground at the Pentland is 14,000 acres. I tested the returns given by the gaugers in different districts during a considerable number of years, and my conclusion is that the mean rainfall amounts to 35 1-10th inches, and adding to that 15 per cent. on account of the greater elevation and necessarily greater amount of rainfall in some parts of the district, I take it that the average rainfall spread over the whole district would be 40 4-10th inches. Those observations were made all over the country. We know that the average ought to be reduced by one-sixth, in order to obtain the correctest possible approximation to the average of the three driest seasons. Therefore, making that deduction in the present case, I take it that the available rainfall would be 33 7-10th inches. From that must be made a further deduction for evaporation and absorption; and, considering the nature of the soil in this part of the country, I consider that the proper reduction to be made on these accounts would be 13 inches, which, deducted from 33 7-10th inches, would leave 20

7-10th inches. Taking the average at 14,570 acres, the available quantity of water would be in a year 6,810,000,000 gallons; 18,500,000 gallons per day; and, multiplying these last figures by 180, which is the number of days for which it would be necessary to provide storeage, it would give a storeage of 1,821 million gallons. That represents a little more than one-half of the necessary storeage. This works out to 50 gallons per head for a population of 250,000 persons. That could be increased from time to time, if the necessity arose, by fresh storeage means. I have visited Norwich. I know, instead of a consumption of 30 gallons per head per day, which at one time was considered insufficient, the population of Norwich are now perfectly satisfied with an average of 17 gallons per head per day.

Cross-examined by Mr. CLERK: My attention was first drawn to this inquiry at the beginning of April this year. I exclude in my estimate of the acreage about 16,000 acres which were included in Mr. Hawksley's estimate, because I take the extent of the existing water supply, and not of the proposed water supply. After looking over the hills, and from my long experience, and knowing the evaporation of the country, I think that 3 inches is quite sufficient to be allowed for evaporation and absorption in the present case. Most of the land is pastoral at the lower part, and in the high land there is a very little peat and some heather. A part of the formation is of a friable porphyritic trap rock, with a little heatber growing upon it. Part of it is mossy. The wet which would run into the friable rock would be caught at a lower position, and it would make very little difference.

Mr. CLERK: Are you aware that the whole of the water flowing on the north side of the Pentlands has been already handed over to the millowners under the North Esk scheme?

Witness: No; I know nothing of it.

Cross-examination continued: A 3-inch gauge is not to be trusted in the exposed position in which this rainfall has to be gauged. I know Mr. Symmons's work on this subject, and in some respects I encouraged Mr. Symmons to prosecute or work out his investigations. Mr. Symmons states in his work that the results given by different gauges, running from 3 to 24 inches, differ very slightly, but he also says that the result of his experience is to cause him to give the preference to gauges of moderately large size. Further, let me state, with regard to the rain-gauges in the Pentland district, that when the use of the small gauge was abandoned and the larger gauge was used, it was shown conclusively that the results given during some few years by the smaller gauges must inevitably have been incorrect. I am not aware how much of this water is already disposed of by existing legislation.

Mr. CLERK: If there is sufficient water on the Pentland Hills, I take it, they being close to Edinburgh, it would involve very little expense to convey the water into Edinburgh and make it available?

Witness: That is so.

Mr. CLERK: And that water, if it has any existence, was just as available in 1869 as it is now, was it not?

Witness: It was.

Re-examined by Mr. RODWELL: It is decidedly important to get the snow measured in ascertaining the rainfall. Snow has always been a trouble to me. It is most difficult to gauge, because with light flaky snow, for instance, it no sooner lights upon the gauge's surface than the wind blows it off again.

Professor *Archibald Geikie*, examined by Mr. RODWELL.

I am Regius professor of geology and mineralogy in the University of Edinburgh. I have surveyed the whole Pentland district for the Government survey with my own hands. I presume I know the district better than anyone else. The Pentland Hills are above 800 feet in height, and the acreage would be between 36,000 and 37,000 acres. The surface is mostly a thin coating of grass, and occasionally heath. It is entirely pastoral, with the exception of little places in the valley, where they cultivate a little oats or turnips. There are about 700 acres of peat in the district, as compared with the 36,000 from which the water drains down in the direction of the Forth—that is to say, about 1-50th of the whole surface.

Cross-examined by Mr. CLERK: I believe the cultivation on the southern side extends to a height of 1000 or 1200 feet above the sea. The southern side is not steep. The only peat marsh of any consequence in the Pentlands is the kitchen moss.

Mr. CLERK applied to be allowed to recall Mr. Bateman, upon the ground that he had not been asked any questions with regard to the Pentlands.

Mr. RODWELL objected to the application, and quoted portions of the evidence of Mr. Bateman, in which the Pentlands were referred to.

The committee deliberated, and in the end the application of Mr. Clerk was granted.

Mr. *Bateman* recalled, and cross-examined by Mr. CLERK.

There can be no question whatever that the Pentland Hills would afford an additional supply of water, but at a cost very much greater than either the South Esk, the Heriot, or St. Mary's Loch. I went into the whole matter previously to making my report in the month of February, 1869, and I have before me the various situations in which I find it would be possible in the Pentland Hills district to construct reservoirs, but their capacity would be so small in comparison with their cost, and the embankments so high, that I rejected the Pentland Hills. When I came to estimate the cost, I found that better and cheaper schemes, with more convenient means of subsequent extension, could be laid out in the South Esk and the Heriot districts. The map I have in my hand will show the committee at once how much more favourable are the sites for reservoirs upon the South Esk and Heriot than they are upon the Pentland Hills. When I came to estimate the cost, I rejected all further consideration of the Pentland Hills district; and in taking that course, I found subsequently that I entirely concurred in the views taken by Mr. Leslie and the water-works company themselves. I was not then aware that there had been any reports whatever made upon the Moorfoot scheme by Mr. Leslie. I had not at that time seen Mr. Ramsay's report in the paper which was read by him before the Royal Society of Scotland upon the exhaustion of the water supply of the Pentland Hills. I dare say you might get 8 million or 10 million gallons a-day of water in the Pentlands, irrespective of any consideration of cost. All the streams flowing from the Pentlands, either on the north or south side, are now completely appropriated by the millowners; but I do not regard the appropriation of the streams by the millowners as a necessary obstacle, because it comes to a question of compensation. You could only have impounded water in the Pentland Hills by the construction of very high embankments in narrow glens and steep valleys; and, first of all, there is the objection to high embankments and artificial reservoirs as compared with a natural basin; and, secondly, there is the cost of construction and the time required. Going to the Pentlands would entail a greater cost upon the inhabitants of Edinburgh than obtaining a supply from a source at twice the distance for the same quantity of water. It would be the greatest possible mistake to go to the Pentland Hills for a supply of water.

By the CHAIRMAN: If there are 36,000 acres, and if the whole of the water was collected, which it is absolutely impossible to do, about 45 millions would be produced. Much of the water, however, falls on highly-cultivated land. It is not all available land by any means; and even if the water could be collected, the expense would be extravagant compared with any other scheme. Mr. Hawksley's estimate of the cost does not allow for any increase of population, and I never considered the question on so barren a basis. I have much doubt, however, that the statement that £100,000, or even two or three times that amount, would give a sufficient quantity of water to keep Edinburgh supplied for the next two years. My experience is that the Pentlands are a bad place to go to for the construction of reservoirs.

The committee-room was then cleared, and on the readmission of the parties,

The CHAIRMAN stated that the committee had decided that they would ask Mr. Clerk to reserve his reply till the whole case of the ratepayers was completed.

Professor *Geikie* recalled, and examined by Mr. WILL.

I am well acquainted with all the districts from which it has been proposed to bring a supply of water to Edinburgh. If you take the whole area of St. Mary's Loch at 28,000 acres, then the area of peat comprised in it amounts to more than 7000—that is to say, to full a fourth of the whole. In many cases the peat is 10, 12, and 15 feet thick. There are some very large peat mosses at the mouth of the Megget, the principal feeder of the loch. The climate in this country is now such that peat is no longer alive. It is all in a state of decomposition, and is being constantly year by year removed. When dead it cracks up into moss "haggs," and in windy weather it dries, and is blown about in brown dust. When rain comes this dust is carried away in the shape of soft mud into the streams, and thence to the lower grounds. These moss "haggs" are being therefore continually removed nearer the loch, and are ultimately carried into the water. I may add that the neighbourhood of St. Mary's Loch is the most peaty tract that I know of in the south of Scotland. The consequence of this is that the water and even the stones in the loch are more or less discoloured. The water is always of a brownish tint. I think the quantity of vegetable matter sufficient to make it unwholesome, but the question is hardly one for a geologist to answer. My own opinion is that it is very unwholesome water. I have also examined the Moorfoot district, and I find that the general surface of the ground is not unlike that of the St. Mary's Loch district, and its character is of the same pastoral kind, but the proportion of peat is very much less as a whole than it is at St. Mary's Loch. In the Heriot water area of 12,000 acres there are little more than 1500 acres of peat—that is to say, about one-eighth of the whole surface of drainage.

Cross-examined by Mr. CLERK: This peat at St. Mary's Loch is not at the top of the watershed, some of it is at the bottom of the valley; at the Winterhope burn, for example. There is a considerable part of it at the tops of the hills, but there are also large quantities on the slopes, and a large quantity at the bottom. I have never found any peat "haggs" floating down the Megget water, but I have seen the Megget water so brown with peat that nobody would drink it. That is not the case with almost every peaty stream in the south of Scotland.

Mr. CLERK: In your pamphlet which you published in 1869, you speak of the most extensive areas of peat being found on the broad flat tops of the Moorfoot Hills.

Witness: But that only refers to a particular district, not to the whole of the south of Scotland. I have tasted the Loch Katrine water, and do not think it unwholesome. I do not think there is more peat in it than in St. Mary's Loch. I cannot say whether the streams that come into Loch Katrine are as brown and peaty as any that come to Moorfoot. The lower slope of the Moorfoot is being broken up for cultivation. The inclination of the hills round St. Mary's Loch is not such as to prevent the possibility of cultivation.

Further examined by Mr. WILL: The whole of the area, including St. Mary's Loch and Moorfoot district, forms part of the great belt of rock belonging to the Silurian formation, which stretches across the island from Ram's Head to the south-west. These rocks are very hard, and are known to geologists as greywacke, and locally as whinstone. They are very hard, and a tunnel could not be driven through them without considerable difficulty and cost. They are full of joints, which serve as channels for the percolation of water from the surface, consequently any tunnel would necessarily be interfered with by the quantity of water which would be encountered. Any pumping-shafts which might be constructed from the surface, would have to pass down through those same hard rocks, and would encounter the same difficulty of water. The tunnel would have to be made perfectly water-tight.

By Mr. CLERK: I have never driven a tunnel myself. Mr. Bateman had to drive his tunnel through material quite as hard for the Glasgow supply, and he did so with success.

MONDAY, MAY 8.

Mr. *C. J. Guthrie*, examined by Mr. MACDONALD.

I am a clerk to Messrs. Gibson, Craig, and Co., of Edinburgh. On the 27th and 29th of March, I took samples of water from St. Mary's Loch, and the Moorfoot and Heriot. These, together with a sample of the Glasgow supply, I sealed up in bottles and sent to Dr. Letheby.

Mr. *R. Leech*, examined by Mr. MACDONALD.

This witness gave evidence of a similar character.

Dr. *Henry Letheby*, examined by Mr. MACDONALD.

I am professor of chemistry and medical officer of health for the City of London. I have been extensively consulted as to the quality of water for the supply of large towns. Every month I make an examination of the water supplied in the metropolis. In conjunction with Dr. Voelcker, I made an analysis of the water of St. Mary's Loch, and of the Heriot, and of the Gladhouse burn, and I have prepared a table and report showing the result. In the first place, we made a careful examination in reference to the colour of the water, and we found that the St. Mary's Loch water was slightly turbid, and very notably coloured with peat. All the other samples were clear, and had a pale greenish or yellowish colour. I produce samples taken, and for the sake of comparison I put in a sample of the New River water as supplied to the metropolis. I attribute the colour in the St. Mary's Loch water to the presence of peaty matter or organic matter. I will put in a table which represents the composition of the various samples. It is the result of the analyses made by Dr. Voelcker and myself, so that they are confirmed by him. In looking at the proportion of ammonia in the several waters, the quantity in the St. Mary's Loch water is very notably larger than that to be found in any of the other samples. Ammonia in the case of peaty water represents putrescent matter. I should condemn this water as a supply to a town on that account. It contains ·015 of a grain per gallon. In the Gladhouse water the proportion is ·005 of a grain per gallon; in the Heriot, ·006; in the present supply of Edinburgh, ·013; in the South Esk, ·009; and in the water of the New River Company, London, ·004. The proportion of ammonia in St. Mary's Loch is not injurious, but it is the representation of decomposing or putrescible organic matter. The quantity of oxygen is very much larger in the St. Mary's Loch water than in any of the other samples, and this, indeed, is confirmed by the appearance of the water; but when we came to the quantity of the saline matter, we found the St. Mary's Loch water contained less of it than any of the other samples. It is 3·17 grains in the gallon; whereas in the Gladhouse burn and the Heriot waters, which are closely alike, the proportion is about 5½ grains; in the present supply to Edinburgh it is 9¾ grains; in the South Esk rather more than 9½ grains; while in the New River Company's water it is 19 grains. I have an opinion that a certain proportion of saline matter in water is necessary; and that is not merely my own opinion, but the result of Royal Commissions in this country, in Paris, and in Vienna. They all agree that the water for the supply of a large city ought to be bright and clear, and that it ought to contain a certain proportion of saline matter. The quantity of organic matter, as tested even by the incineration process, is considerably more in the St. Mary's Loch water than in any of the others. The largest constituent in that water is peaty matter. If that were taken away, the proportion of saline matter would be infinitesimally small—less than two grains. It is very soft water indeed. The degree of hardness is 1·3° before boiling, and after boiling 1°, whereas both in the Gladhouse burn and the Heriot it is rather more than 3½° before boiling, and 2½° after boiling. In the present Edinburgh supply it is nearly 7° before boiling, and 4° after boiling. In the South Esk it is nearly

3·6° after boiling. The New River water is 14° of hardness. St. Mary's Loch is therefore less than one-half of the lowest of the waters I can compare it with. We examined the Loch Katrine water, and found that it contained 2·68 grains of saline matter per gallon, of which ·8 was organic.

By the CHAIRMAN: The New River Company's water contains 18·73 grains of saline matter per gallon; St. Mary's Loch water contains 1·92 grains; Loch Katrine water contains 1·8—that is, about a tenth of a grain less than St. Mary's Loch.

By Mr. MACDONALD: The water of Loch Katrine is slightly turbid. It is of a yellowish-green colour. The proportion of ammonia per gallon is ·003; ditto, organic, ·010; oxidizable matter, ·110; earthy carbonated matter, ·35; sulphate of lime, ·64; common salt, ·79; nitrates, non-silica, ·10; organic matter, ·80—making altogether, 2·68. As to the hardness, it is 1·3°; and after boiling, 1·2°. The action upon lead is not quite so great as in the case of the St. Mary's Loch water. On new lead it is rather strong, and on old lead it is not so. It is nothing like so strong as in the case of the St. Mary's Loch. I can get that in the course of half an hour or three-quarters of an hour to act upon lead. We have made a great many experiments on it, and found it a capricious water. Old lead, which is coated with a certain varnish or crust of oxide, is not affected much by it, although after standing in contact with it for a week, there is a marked action, amounting to a grain of lead, dissolving in 7 or 8 gallons of the water. Upon new lead, scraped, it will act in half an hour or three-quarters.

Mr. MACDONALD: How does the water act in relation to the tests?

Witness: Sometimes it does not act at all, and sometimes it will. Like all waters containing peaty matter, it is capricious. It is the presence of that peaty matter which makes the difference in the action of that water as compared to that of Loch Katrine. I have examined the mortality returns issued weekly by the Registrar-General, and I have also taken certain other towns for examination on my own account and basis. With regard to the 19 large towns to which the report of the Registrar-General refers, I have found that in cases where the water averages about 15° of hardness the death-rate is 23·7 per 1000; whereas in towns whose water supply averages 4° to 5° of hardness, the mortality is about 28 per 1000. These results accord with those arrived at by French physicians, who some time back made an inquiry as to the mortality and its causes in France. I have taken from the pamphlet of "A Physician" certain figures which give a remarkable confirmation to the views I had myself formed. It is, in my opinion, an undoubted fact that as you diminish the hardness of the water, the rate of mortality rises. Many of the figures contained in the tables which form part of the "Physician's" pamphlet are taken from calculations made by myself, and they, together with the figures resulting from the personal inquiries of the "Physician," show conclusively to my mind that the conclusion at which I have arrived is an accurate one. In towns where the hardness of the water averages 10°, the rate of mortality will be 22 in the 1000. Towns with an average of 8° of hardness will have a death-rate as high as 25 in the 1000; in towns where the hardness of the water is 3·8, the mortality is 26·3 in the 1000; and in towns where there is the softest water of all, or 2°, the death-rate rises to 28·4.

By the CHAIRMAN: The hardness of the water in Liverpool is from 3 to 4 degrees. It is my deliberate conviction, after an experience extending over many years, and relating to large towns both in this country and on the Continent, that there is an intimate relation between the mortality and the quality of the water supplied, after making allowance for the density of the population, because in many places where there is the largest mortality there is the least number of people upon an acre.

By Mr. MACDONALD: A great deal has been said in reference to the hardness of water causing a waste of soap in washing, but I do not think the difference is an appreciable one, and I think further that the pressure in water of a small quantity of saline matter is infinitely more important than the mere question of the colour of water. If such water as this water were delivered to London, the Londoners would be up in arms at once; they would not drink it. In selecting the towns which figure in my table, I take first the nineteen towns used by the Registrar-General in his report, and then I take other twelve towns with hard water and twelve towns with soft water supply. I know several other towns in which the hardness of the water is reduced by boiling to 1 degree. Unless they were to be reduced to the necessity of using the St. Mary's Loch water, I think it is not the proper source of supply for Edinburgh. There are no manufactories in the city requiring soft water, and there are several breweries that require hard water; in addition to which, the appearance of the St. Mary's Loch water gives great dissatisfaction. It is a dangerous water also, because it is a capricious water. It might be safe for years, but then the danger would come suddenly and unexpectedly. It would commence to act upon the lead, and the lives of the people drinking it would be endangered.

Mr. MACDONALD: Then, if there is any other source of supply, you would recommend its adoption in preference to that from St. Mary's Loch?

Witness: Decidedly yes; either the Heriot or the South Esk.

Mr. MACDONALD: If a supply could be got from the Pentlands, in addition to that which the city has at present, do you think that would be preferable?

Witness: Yes; the Pentland water is very much of the same quality as that at present in use.

Cross-examined by Mr. CLERK: I did not filter the water before analyzing it. I should not filter the water unless it contained insects. Being turbid, I should allow it to settle, and then syphon the water off. I did not see any insects in this water. If the margin of the stream from which the water was taken had been disturbed, and a good deal of sedimentary matter had been taken, I should have observed the fact, and allowed it to subside before attempting an analysis. The New River water passes over filter-beds before it reaches the consumers. I have not examined any of the samples produced by Dr. Stevenson Macadam. There was no acidity in the samples sent me that I could detect by means of test-papers.

Mr. CLERK: Would there not be more ammonia in solution in rain water than in these samples?

Witness: Yes; there would be more than ·004.

Mr. CLERK: And do I understand that there was more organic ammonia in Loch Katrine than in the water taken from St. Mary's Loch?

Witness: No; the proportions were ·015 in St. Mary's Loch, and ·010 in Loch Katrine. I do not regard Loch Katrine water as being proper for the supply of a town if there was any other better water available. Dr. Frankland takes the Loch Katrine water as a standard of purity. He regards saline matter in water as an impurity, but it is not; and I consider that to describe it so is to use an improper expression, and one calculated to deceive the public. It is a purity—if I may use the expression—in so far as it ministers to the water of the body, and prevents water becoming charged with putrescible matter. I think that water might contain peaty matter to an extent sufficient to give it the colour of ale without being injurious to health; whilst water containing organic matter in solution, though it may be crystalline clear, would be decidedly deleterious. My experiments were made with peaty water, compared also with the pyrogallic acid. Here I have one grain and a quarter of peaty matter, some of which has undergone oxidation, and it is there to keep up the colour of the water. There is no pyrogallic acid in peat, but I converted my pyrogallic acid into a product which is just comparable with peaty matter. I have never visited St. Mary's Loch. I have been to Loch Katrine. I have never been round the lake to ascertain how it is fed. When the peat is oxidized, and altogether converted into these peaty acids, then it is that there is a large portion of peat. When it is oxidized the colour itself goes, but the first step of the oxidation is to produce colour by rendering it soluble. My opinion is that water absorbs oxygen comparatively quickly, and the organic matter undergoes oxidation.

Mr. CLERK: Is there any other man in Great Britain, except Dr. Letheby, who adopts, as the mode of testing impurities in water, the plan of ascertaining the quantity of oxygen and oxidized matters in the water?

Witness: Yes; Dr. Voelcker and the late Professor Miller, of King's College, invariably followed this test.

Mr. CLERK: There is one almost invariable mode of proceeding—namely, what is called incineration, is there not?

Witness: No; the plan I have followed is pretty much that which is followed by most people.

The CHAIRMAN: What is the test of incineration?

Witness: After the water has been evaporated—say 2-10ths, or a fifth of a gallon has been evaporated—and the residue has been exposed to a sufficiently high temperature to drive away all the water and the ordinary volatile constituents, the remaining particles of that water are then exposed to a red heat in the presence of the atmosphere. The oxygen air burns away the organic matter, and the loss by incineration is set down to organic matter, and that is what is called the incineration test. But we find it to be a very uncertain proceeding. My colleague at the hospital made more than 200 experiments for the purpose of ascertaining whether the incineration test might be relied upon, and the result proved it to be so utterly unreliable that I would not try it.

By Mr. CLERK: All the analyses which took place before the Rivers Pollution Commission were based upon the process of incineration. I am not aware that the Rivers Pollution Commissioners attached the slightest importance to the analysis. The same process was adopted in the Royal Commission on the London water supply, simply because Dr. Frankland made the analysis. At that time Dr. Odling, with myself, thought that process was manageable. It is very material whether a hard or soft water is supplied to towns. The question is what you call a hard water. I say that anything between 10 and 5 degrees is a water that may be called not hard water. In 5 degrees of hardness you begin to find a curdling or breaking of soap. That is only in the chemical experiments; you will not notice it in washing. The question of a little lime in water, as far as regards water, is of no importance. I gave evidence on the East London Water-Works inquiry. London water acts very little on bright lead. It may stand in contact with bright lead for almost any time, and we cannot get anything but the faintest evidence of action. It is known as a matter of fact, medically, what proportion of lead in water will do mischief. One grain of lead dissolved in below 10 gallons of water is unsafe water to drink. It is an ascertained fact that, although there is little action by the water upon bright lead, yet it assumes, after a time, a kind of coating or varnish, which prevents any further action of the purest water upon the lead; but, as water can be got upon which there is no action at all, why run the risk? because the slightest cleaning of the cisterns brings off the varnish. There is an action by the purest water upon the dull lead of an ordinary lead pipe. There is an action by the St. Mary's Loch water, if I keep it in contact with the dull lead.

Mr. CLERK: There ought to be considerable injury being done at present in Glasgow by the introduction of a water which has less saline mater in it than that of St. Mary's Loch?

Witness: The danger may appear all of a sudden. If any accident removes the rust so as to expose a bright surface, it will bring dangerous consequences. The symptoms of lead-poisoning are so varied—apoplectic, paralytic, and all sorts of things—that, unless a physician is accustomed to it, he would not trace it to the lead; he would put it down to natural causes. The mortality of Glasgow has risen since the Loch Katrine water has been brought in. The St. Mary's Loch water will act sometimes on old lead, and not upon other kinds. I agree with the late Dr. Miller when he says: "Sometimes, as in the pure lake waters of Scotland, the presence of a little vegetable matter acts as a preservative agent by combining with a part of oxide of lead, and forming an insoluble and closely adhering natural pigment, which lines the pipes;" but, if that vegetable matter goes further in its oxidation, and becomes acid in its action, then it dissolves it. When it is removed—for instance, by cleansing the cistern—it is always risky in regard to the action of water upon the surface. Infantile mortality holds no inconsiderable place in the death-rate of large towns. It is very much larger in manufacturing than in non-manufacturing towns. I have eliminated the infantile mortality, in order to see how the death-rate would compare, but I have not the results with me. I do not maintain the theory that soft water kills people. There are many other causes affecting mortality, such as food, overcrowding, and the manner in which local sanitary arrangements are carried out. If it be nothing more than a coincidence, it is a remarkable fact that there is generally a high rate of mortality where there is a soft-water supply, and a low rate of mortality where the supply is hard. In the Brechin case I gave evidence in favour of soft water because it was the only water to be got. If there is no other water to be had, I generally do give evidence in favour of soft water, on the principle that it is preferable to none at all.

Re-examined by Mr. MACDONALD: Wherever artificial reservoirs are made to receive water that may now and then contain peaty matter, it is a common practice to take care that that peaty matter does not pass into the reservoir, whereas in a lake you must take it as it comes. By the use of a reservoir, you can always let go by the water you do not want to receive, because of its being so highly coloured. The greatest number of the larger towns have their water stored in reservoirs of that character, and I have never found any complaints made. The practical results of the table I have given is, that where you have hard water the rate of mortality is smaller than where you have soft, and the evidence tending in that direction is becoming more and more conclusive every year.

By the COMMITTEE: The sphere of selection in the taste of soft-water supply is by much narrower than that of the hard water. That accounts for the numbers specified in the table of comparison. Speaking roughly, the average death-rate of the towns omitted from the second list is one per 1000 more than in the first, and I have picked out the towns supplied by the very hardest water, while I have given all the soft-water towns I knew anything about.

The following papers, extracted from Dr. Letheby's annual report on the sanitary condition of the City of London for 1870, were handed in:—

Comparative Mortality in the Nineteen Large Towns of England and Scotland referred to in the Registrar-General's Weekly Report for 1870, *arranged under the heads of Hard-Water and Soft-Water Supply—*10 *degrees of hardness being taken as the standard.*

Hard-Water Supply.

Towns.	Death-rate per 1000.
London	24·1
Portsmouth	20·1
Norwich	27·4
Bristol	29·9
Wolverhampton	21·8
Birmingham	21·1
Nottingham	24·1
Hull	21·8
Sunderland	20·1
Newcastle-on-Tyne	24·1
Leicester	26·6
Average	23·7

Soft-Water Supply.

Towns.	Death-rate per 1000.
Liverpool	34·1
Manchester	27·8
Salford	26·1
Bradford	27·4
Leeds	28·1
Sheffield	25·3
Edinburgh	26·1
Glasgow	29·5
Average	28·1

Death-rate in England . . 23·5.

Comparative Mortality in Twenty-four English and Scotch Towns, during the years 1861 to 1865 inclusive, arranged under the heads of Hard-Water and Soft-Water supply—10 degrees of hardness being the standard.

Hard-Water Supply.

Towns.	Death-rate per 1000.
London	24·39
Guildford	19·45
Dover	20·96
Southampton	22·11
Reading	22·19
Bedford	20.72
Ely	21·55
Chelmsford	19·83
Gloucester	23·83
Cheltenham	18·52
Birmingham	26·42
Sunderland	23·99
Average	22·00

Soft-Water Supply.

Towns.	Death-rate per 1000.
Exeter	24·72
Plymouth	22·56
Liverpool	36·41
Manchester	31·89
Bradford	26·74
Leeds	30·32
Sheffield	29·40
Northampton	26·15
Carlisle	24·05
Preston	26·63
Edinburgh	26·73
Glasgow	30·90
Average	28·04

Death-rate in England . . 22·68.

Tables showing the Quality of the Water Supply as regards Hardness, and the Death-Rates in 65 English and Scotch Cities and Towns, compiled by Dr. Charles Wilson.

Hardness over 10 degrees.

Places.	Death-Rate per 1000.	Deg. of Hardness.
Banbury	21	16·9
Bedford	19	24·3
Birmingham	27	15·5
Bristol	28	17·1
Canterbury	23	18·0
Cheltenham	19	12·0
Congleton	23	11·9
Croydon	19	16·4
Deal	20	18·4
Derby	24	14·4
Dover	20	17·0
Guildford	19	18·5
Leamington	20	18·5
Lincoln	20	11·0
London	24	15·5
Newcastle & Gateshead	26	19·5
Norwich	25	14·5
Rugby	19	11·1
Runcorn	21	17·7
Southport	19	19·5
Sunderland & S. Shields	24	12·6
Wakefield	23	16·0
Warrington	24	12·7
Worthing	18	14·3
York	23	14·3
Average	21·9	16·0

Hardness from 10 to 6 degrees.

Accrington	29	6·9
Ashton-under-Lyne	27	9·9
Birkenhead	19	8·3
Carlisle	23	6·1
Durham	23	7·5
Edinburgh	25	7·0
Leeds	28	7·5
Leicester	25	9·4
Leith	23	7·0
Liverpool & West Derby	28	9·6
Macclesfield	25	5·9

Hardness from 10 to 6 degs. (continued).

Places.	Death-Rate per 1000.	Deg. of Hardness.
Northampton	24	7·2
Northwich	22	9·8
Preston	27	6·3
St. Helen's	26	8·9
Wigan	27	8·4
Worcester	23	10·0
Average	24·9	8·0

Hardness from 6 to 2 degrees.

Blackburn	29	4·1
Bolton	27	3·4
Bury and Radcliffe	23	3·8
Chorley	22	3·8
Chorlton	24	2·5
Dundee	29	4·3
Manchester and Salford	29	2·5
Maryport	24	2·3
Oldham	25	4·9
Over Darwen	34	4·4
Paisley	28	2·9
Plymouth	24	3·0
Preston	27	5·5
Rochdale	24	3·6
Stockport	26	5·8
Average	26·3	3·8

Hardness less than 2 degrees.

Aberdeen	26	1·4
Cockermouth	33	1·5
Glasgow	31	0·6
Greenock	32	1·3
Lancaster	30	0·6
Perth	26	2·0
Sheffield	28	2·0
Whitehaven	22	1·0
Average	28·5	1·3

Summary Abstract.

Degree of Hardness.	Average Death-Rate per 1000 of Population.	Average Degree of Hardness.
Over 10	21·9	16·0
10 to 6	24·9	8·0
6 to 2	26·3	3·8
2 and under	28·5	1·3

A. Voelcker, Esq., examined by Mr. MACDONALD.

I am professor of chemistry to the Royal Agricultural Society of England. I have received samples of water which were sent up from Edinburgh to Dr. Letheby and myself. The result of my analysis agrees very closely with that of Dr. Letheby. I found the total solid matter in the St. Mary Loch sample to be 3·17. I do not think it is so good as the Heriot water, or even as the present water procured from the Pentlands. The St. Mary's Loch water contains too much organic matter, and is altogether too soft. It is not desirable as a source of supply when you have others so unobjectionable. All chemists are agreed that soft water has more action upon lead than hard water. The St. Mary's Loch water, I find, acts more on lead than either the Heriot water or the present supply.

Cross-examined by Mr. DENISON: I delivered a lecture in 1864 on the chemical properties of water for economical purposes. There is nothing in that lecture suggesting that the water can be too soft. I do not think the St. Mary's Loch water is deficient in carbonic acid. Hard water acts upon lead when it contains the same constituent as soft water.

Dr. *Charles Wilson*, examined by Mr. MACDONALD.

I am a physician residing in Edinburgh. All my life I have taken an interest in sanitary inquiries, and lately I have directed my attention to the question of the St. Mary's Loch water. I wrote a number of letters to the *Scotsman* under the signature of "A Physician." I have read the evidence of Dr. Wood and Dr. Maclagan about the question of rickets. I have not changed my mind in consequence. Dr. Wood stated that I was not aware that rickets was caused by an excess of lime in the system. I did not say that lime should be used for curing rickets, but that it was useful to prevent the disease, prevention being much better than cure. The administration of lime has been recommended by the leading practitioners in France, Germany, and Great Britain. Virchow, the pre-eminent pathologist, gave lime, and especially carbonate of lime, and recommended it. Trousseau expresses the opinion that phosphate of lime ought to be supplied in greater quantity, and that the want of it was one of the causes of rickets. Dr. Stille and Sir William Jenner also recommended lime. Therefore I say that the charge of my statement about lime showing an ignorance of medicine falls to the ground. I hold it is utterly unproved that water fleas are innocuous. A friend in Stockholm has sent me some interesting cases, in which water fleas had been found living in the intestines of people who had long suffered from diarrhœa. I got my materials from the tables of mortality given from returns of a public nature, and amongst others from the reports of the commission on water supply and the commission on the pollution of rivers. I also got some information from the professor of chemistry at Aberdeen. I should consider it a great hardship for a people to have a water thrust upon them to which they have a repugnance, and, so far as my experience goes, the objection to this scheme is universal through all the intelligence of the city. I should think it a hardship, even though the water could not be proved to be prejudicial. The people believe they have a right to have their lives pleasant, as well as safe.

Cross-examined by Mr. DENISON: If the city is divided on the subject, the course to be adopted is exceedingly simple. There is one water that no man challenges, and that must be taken. The minority are quite right to determine, if the minority is 19 to 23; and I think that if the majority do not yield to such a minority, they are a very tyrannous majority indeed. The fleas found in the persons with the diarrhœa were not the fleas meant in the present case. They were animalculæ. A few insects may be found in any water.

Mr. DENISON: Dr. Baird, an authority on such matters, points out that while these animalculæ are most abundant in stagnant water, they are found in most waters, including those supplied to towns. They have been found occasionally in Edinburgh water. St. Mary's Loch is decidedly stagnant.

Re-examined by Mr. MACDONALD: Water is stagnant wherever its main body has no perceptible current, and thus there may be stagnant pools even in a river. I have made the following note:—"Computing with Mr. Bateman the superficial extent of the lochs at 725 acres, and the average depth at only 10 fathoms, this would give, as their contents, 11,842,875,000 gallons. Taking the outflow to be assigned to Selkirk of 15 million gallons daily, and alleged to be above their average summer supply (one-half more than minimum, probably three times the minimum) as necessarily the equivalent of the inflow, on which alone the refreshing power depends, the relation daily of the latter to the gross contents is as 1 to 789; and yet the lake, with this overwhelming proportion of unchanged contents, is denied to be a stagnant waste water. With 5 millions of gallons of overflow, the proportion of fresh to unchanged water becomes as 1 to 2367, and with 3 millions is only 1 to 3945."

James Glaisher, Esq., recalled, and examined by Mr. MACDONALD.

Taking the area of the Lyne at 6734 acres, I determine the available rainfall as about 3153 millions of gallons. That would be about 8½ millions a day, and, deducting the usual proportion of compensation, would give about 23 gallons to a population of 250,000. Taking the Moorfoot and South Esk area at 15,398 acres, I determine it to be something like 7000 million gallons, which would give 50 gallons per day for the same population. Taking the area of the Heriot at 12,000, I determine it at 5000 and odd million gallons in a year, or 15 millions a day, which, after deductions, would give 40 gallons per head for a population of 250,000. I have also visited St. Mary's Loch. There was a slight rain at the time, and the colour of the water was brown. I could see a depth of two or three feet into the water, but no more; all the stones had the appearance of being permanently coloured. I examined the valleys in the neighbourhood, and I found that above the small lake there was a good deal of peat in the valleys. I agree with Mr. Bateman as to the rainfall in St. Mary's Loch.

James Leslie, Esq., examined by Mr. MACDONALD.

I am a civil engineer in Edinburgh, and was consulting engineer for the Corporation Water Trust. The supply which is taken from the South Esk for Musselburgh and Dalkeith does not at all diminish the supply from the same source to Edinburgh according to my plan. About 9 million gallons a day are available for Edinburgh at the South Esk, and almost as much as that for compensation. This is more, however, than is required for compensation, and therefore you would have plenty out of it for Musselburgh, and something to spare. There would be no difficulty with the water supply for all these places coming from the South Esk. At the same time I was asked by the Water Trust to report on all the different schemes that had been proposed, and I did so. I see no reason to change any of the opinions I then expressed. In calculating compensation we usually take two thirds for the use of the town, and the other third, distributed equally over the year, goes to millers for compensation. In the Paisley works only a fourth was given as compensation, but a third is the usual thing. I know the Heriot district perfectly well. The quantity of water obtainable from it for the supply of Edinburgh is much about the same as from the South Esk; but it would depend very much on the way you treated it. I never have gone into this scheme so thoroughly as I have into the South Esk. The Esk scheme was thoroughly surveyed and estimated, but the Heriot was more roughly taken. They are both, however, perfectly feasible schemes.

Cross-examined by Mr. DENISON: I have not prepared an estimate for the St. Mary's Loch scheme. I have recommended the Pentlands scheme. When I talked of getting these 9 millions a day for Edinburgh, I did not include any water to be taken from Fullerton burn. The Fullerton burn was to go in compensation; we were to take some of the upper sources of that burn—two sources which are perfectly free from moss—and divert them into the reservoir upon the South Esk. The compensation was 83⅓ cubic feet per minute. It was increased to 90 feet.

Re-examined by Mr. MACDONALD: In the Musselburgh and Dalkeith Water Bill the promoters got the same quantity of water, but were obliged to give off a larger proportion for compensation than was originally intended. I suppose the present scheme for getting water from St. Mary's Loch is substantially the same as the original one which was laid before Parliament, but I had no share in the preparation of the plan.

By the CHAIRMAN: I read Mr. Hawksley's evidence as to the Pentlands. The Edinburgh supply to the west of the Leggat burn is all from springs, and there would be large compensation reservoirs to supply the mills. To show that this water is brown and mossy, after having given all that compensation in the way of storeage for driving the mills, the company were obliged to give a large quantity of pure spring water out of their pipe to the paper-mills.

The CHAIRMAN: What is your opinion as to the possibility of getting a largely increased supply from the Pentlands?

Witness: I have proposed works for getting an additional supply. You might, by making a reservoir above Glencorse, prevent the recurrence of such a scarcity of water as was experienced last year, and if you do that you can never have any very great destitution. If you go any further, however, I am afraid you may come into collision with the millers. The last time we interfered with the Glencorse the millers claimed additional compensation, and got 25 feet per minute. This is probably more a lawyer's matter than an engineer's; but this I can say, that if the additional reservoir were constructed, you would require to lay a new pipe to Edinburgh, the present one not being large enough. There are no difficulties in the way of making reservoirs at a moderate cost in the Pentland district. I believe there has been a great waste, and that it could be reduced considerably. There never was any surveillance over the waste of water until lately. I know the character of the alterations on the fittings proposed by Mr. Hawksley. I think that if these improved fittings were introduced into Edinburgh the waste would be so far stopped that the existing supply would be made sufficient. I recommended the water company to look out for a water supply because Edinburgh was increasing very much, and I thought it bad to leave the thing over too long. I thought it right that some scheme should be proposed. I have not estimated the present scheme, but I do not see why there should be much difference between it and the original one which I estimated according to the way I thought the work ought to be done. My estimate was in excess of that of the Trust's own engineer.

The CHAIRMAN: Was that due to the tunnelling?

Witness: It was due to a great many different things. The amount of tunnelling in the present scheme is about eight miles. I put down for this £12 5*s.* a yard, including the shafts.

TUESDAY, MAY 9.

James Leslie, Esq., Recalled, and cross-examined by the CHAIRMAN.

I have considered Mr. Hawksley's evidence since yesterday. I concur to some extent with Mr. Hawksley, but on the whole I cannot say I agree with the evidence he has given. I believe he was right when he said we had an area of 36,000 acres, but I do not think we could get the water out of it that he spoke of getting. Then, as to the escape from the Glencorse reservoir, I do not know whence he got his data. I cannot find out anything like that. I do not think Mr. Ramsay has the means of getting correct data of that. It is stated that there is a book which gives the overflow at Glencorse Weir. The waste book does not furnish any material for giving the waste—it gives you one height of water in each day. Now, that amount might have overflowed for one hour, or for two, or six, or ten hours, but it is taken on all occasions as if it had run the whole day—during all the 24 hours. The 4 million gallons of water which Mr. Hawksley takes would require an available rainfall of 33 inches, which is a great deal more than that district would yield. I think, however, a good deal might be done by additional storeage at Glencorse. You might get, in the first place, as much as would prevent the pipes ever being short of water, and you might probably do more and give storeage which would serve for another new pipe, but in that case I do not know that you would not have to fight the millers again for more compensation.

The CHAIRMAN: If you make alterations in the Glencorse reservoir to prevent the present supply-pipe being exhausted, what would that give to the population?

Witness: It would not give more than the present maximum; you could not get any more than that. If the supply were full from other quarters, it would give 9 million gallons a day, equal to about 36 gallons a head for 250,000 people; but last summer the supply fell short of that. If last year there had been these alterations in the Glencorse reservoir, we should not have fallen short of that, because the pipe would always have been supplied. I think that 25 or 30 gallons per head per day would be ample if there were no waste in the domestic supplies. I never had the charge of the town supply in Edinburgh; that was always in the hands of the manager, and I merely made the larger works. The way in which most water could be got from Glencorse would be by cutting off the 250 feet of water that goes to the millers, and make compensation reservoirs on the North Esk for supplying the millers there. If you could take that 250 feet, you would get most water, but there are difficulties in the way. There is one mill-owner, for instance, who is upon the Glencorse Burn alone, and there are others further up who get none of the 250 feet now, but who would get the whole of it afterwards in addition to what they have now. It could be done, however, but there are considerable difficulties in the way of doing it. I know nothing of the table. The table handed in to the committee, which gives the waste at nearly 4½ million gallons, cannot be correct, because if it were it would require 33 inches of water to run off that district, which is a great deal more than ever does run off. We take just now 16 inches, and it is not possible there can be 17 inches in addition. I disagree with Mr. Hawksley's estimate that from the 36,000 acres above the 800 feet contour the amount he contemplates could be obtained. A great part of the water he relies upon is not fit for drinking, supposing you got it all. It is all moss water at the north side, except spring water, which is appropriated already. There are certain springs which have not been taken yet, and which were intended to be taken by the last bill, but they were omitted from the Act because they required compensation reservoirs. I cannot tell the quantity that could be obtained. No further supply could be got into Edinburgh except through a new pipe after the Glencorse reservoir was full, except what is wanted to fill the pipe. By improvements in the Glencorse reservoir we could obviate the present waste and always obtain the present maximum supply from that district. There might be an improvement made on the north side of the hills. There is one small reservoir which an Act was got for and never executed to store up water to serve for a dry year. But one great advantage in the Edinburgh system of springs is that you never can run short altogether. It is not like a place that can run dry, there is always so much water with a steady supply.

By Mr. WATERHOUSE: I do not think it is possible so to improve the system of distribution as to reduce the consumption to 6 million gallons per day. I think we ought to have something near 9 million gallons per day, which would allow 36 gallons per head per day; and then you would have to take off what is required for manufactures and trade, which is, I believe, about an eighth.

Mr. WATERHOUSE: Assuming there was half the present waste, that would be equal to 8 gallons per head of a population of 250,000; this would not entail on the Water Trustees any increased amount of compensation to millers, paper-makers, and so forth.

Witness: Of course you have to give no compensation for what you save by preventing waste. If you were sure you had the 4 million gallons of water at Glencorse, it would be very easy to utilize it; but I very much question whether there is that amount. In my instructions from the trustees, I was told to report generally upon all the different schemes brought forward, and I reported upon six or seven. I did not think there was anything in the Pentland district worth consideration at that time. When I reported to the water company—long before the formation of this Water Trust—I did not think of going to the Pentland district. In my judgment it would be unwise to depend on that district for any considerably increased supply to Edinburgh, but some parts of the Pentlands are more than sixteen miles away. The relative cost of getting water thence would be quite as great as going to a greater distance. Because you must shut out the north side of the Pentlands altogether. You cannot get anything there, and on the south side the water runs into the Esk, so that you would have to give large compensation. I am not a chemist, but it strikes me that St. Mary's Loch water is very good water.

By the CHAIRMAN: One of the points on which I differed from Mr. Stewart was as to the number of shafts required; I said he would require many shafts for such a large tunnel, and that they were very expensive things to make. If you do not make a great many shafts, the work goes on very slowly. The Greenock tunnel, which is about a mile long, took three years to drive. I differed from the trustees, because I thought the scheme would cost more than they supposed. I do not know whether machine labour is to be employed in the construction of the tunnels. The parliamentary plans have been made since I was consulted. Hand labour might do it.

By Mr. WATERHOUSE: From the slaty nature of the rock it is liable to take in much water. I originally estimated at £650,000, which was for 15 gallons I was told afterwards to reduce the quantity to 10 millions.

By Mr. DENISON: I came down to about £570,000. I was told that the committee would not approve of any estimate above £500,000. I would not sign that estimate, and there our connexion ceased. I believe Mr. Hawksley's estimate included the purchase of the works. Without allowing for contingencies, my estimate was £483,000, against Mr. Stewart's £407,000, being a difference of £75,000. There was no provision large enough to settle the town reservoir, and I thought, in all probability, filters would be required before we were done with that; and then I wanted a double outlet at the loch—one for the mill water, and to level the flood water in winter, and the other for the town water. I thought these things indispensable, and Mr. Stewart thought not. In my first estimate I brought the pipe to Castle Hill, instead of stopping at the outskirts of the town, where the plan proposes to do just now. That might add £10,000. I had more for tunnels than Mr. Stewart. I think there would be great objection in Edinburgh to enforce the use of such fittings as are used in Norwich.

Mr. *John Ayres*, examined by Mr. MACDONALD.

I am manager of the water-works at Norwich and Great Yarmouth. My attention has been directed for many years to the control of supply for preventing waste. In 1858, in the supply of water at Norwich, the water run off by the inhabitants from the works was 40 gallons per head per day, and the water was turned off at night at the works, in defiance of the Act, as we had not sufficient power to pump it. We applied to Parliament, and obtained complete control over the fittings, and we then proceeded at once to put that power into force by laying down a code of rules and regulations, and giving the inhabitants notice that they must comply with them, or have their water cut off. There was considerable dissatisfaction among the inhabitants at first. The result has been that for the last seven or eight years the supply of water has not exceeded 15 gallons per day, and the inhabitants are perfectly satisfied. There is constant pressure night and day, and there are no complaints. At Norwich, the alterations required were more extensive than would be the case in Edinburgh, where the service-pipes leak very little, and are mostly above ground, running up to supply these tremendously high flats; but in Norwich the service-pipes, which were under ground, were exceedingly light, burst in all directions, and had to be renewed, as had also the taps and water-closets. In the case of Edinbugh, these last are the only portions of the service that would call for much attention or alteration.

By the COMMITTEE: They would want the water introduced from the street. At present one feeder goes from the street, and it branches off right and left in several directions. Each pipe would require to be carried across the street from the company's main to give a better supply. If the water is running to waste in the cisterns in Norwich, it becomes known by detectors or running-pipes being laid out where they can be seen, instead of running into the sewers. In 1868 I went to Edinburgh, and visited houses of all kinds. I had an official of the water company with me, as I was a comparative stranger. He took me into the different districts, and I chose the houses myself. I found that in almost every case the taps leaked. The exception was to find one that was tight. Seeing a great many small leaks that I thought the water company's official did not thoroughly appreciate, I sent to a public-house and got an imperial gallon measure. One small leak we found running at the rate of 110 gallons in the 24 hours, and that was not even considered a leak by the inhabitants of the house or by the water company's manager. Another tap in the same house leaked to the extent of 207 gallons in the 24 hours, and I saw some leaks by which the water was wasted more than 10 or 20 times that amount. I was enabled to find out the relative waste in other places, having measured the waste at those two taps.

Mr. MACDONALD: If the waste were checked in places like Edinburgh, how much water do you think would be amply sufficient for the inhabitants?

Witness: They have a great many water-closets and baths in Edinburgh, and I should therefore give more water to Edinburgh than any other town I know of, but 25 gallons per head per day would be a most abundant maximum supply. Including trading and all other purposes, I really do not believe they would use it all. The consumption of Sheffield in 1869 was 40 gallons per head per day. We are now introducing new taps similar to those in use in Norwich, and we have already reduced the consumption to 24 gallons, and I have no doubt we shall succeed in reducing it to 20 gallons. In Sheffield there has been a great complaint of the want of water, arising in a great measure from the same cause as at Edinburgh. There are a great many cisterns and tanks in lower flats, and when they leak the people living in the upper flats get no water. That would be the same if you were to take more water into Edinburgh. If you were to give 40 gallons per head to the people of Edinburgh, those living on the top flats would never get supplied while the fittings remain as they are. I find that by the company doing the plumbing themselves they sometimes do it for one-fourth or one-eighth the price that plumbers would charge. It is much to the advantage of the inhabitants of the town that the company should do plumbing to some extent, the trade, of course, still being open.

Cross-examined by Mr. DENISON: Companies have more power than corporations, because they are not an elected body. If a corporation attempts to do that which the inhabitants of a town do not like, they soon hear of it in an unpleasant way. The consumption at Manchester in 1867 was, I think, 23·15 for all purposes. They are corporation works there. I did not ascertain whether the people of Edinburgh were willing to be put under a similar control as Norwich. I made no estimate of what it would cost to make the necessary changes, because I had no record of the number of closets; but it would cost about 15s. for each closet.

Alex. Ramsay, Esq., examined by Mr. WILL.

I was manager of the Edinburgh Water Company upwards of 25 years. There is enormous waste in consequence of the defective fittings, both in the city and the country, which might be prevented with better apparatus. In 1856, and again in 1863, the company came to Parliament, and there was a proposal made to obtain the same powers to prevent waste that Parliament had given to many other towns—Norwich included—but it was very strongly opposed by the Town Council of Edinburgh, and the consequence was that the company were forced to give up the idea of prosecuting the matter further. I still hold the opinion I expressed in 1869, that if I had those powers I should have been able to have given an abundant supply of water to Edinburgh, Leith, and Portobello, with a large surplus as well. I cannot give any accurate figures of the waste in the city, only a mere guess; but I am sure I put it rather under the mark at 38 per cent. of the whole quantity of water sent into Edinburgh. In my judgment there would be no difficulty, except the cost, in carrying out those powers to control waste if the Water Trustees had applied for them and obtained them. It would cost a good deal of money. When they applied for the powers the company were not prepared to spend money for fittings; the cost of the fittings was to fall upon the consumers. The same results would follow as at Norwich and other places, the cost of rectifying the fittings in each house would be borne by the landlord, and not by the company; so that the outlay required to put the fittings of Edinburgh in a proper state would be distributed over all the landlords throughout the city. Every year during my connexion with the water-works there has been a large quantity of water running over the waste weir. I was glad to find that Mr. Stewart, in making a calculation for two years, made it larger than I had made it. I consider that Mr. Hawksley's table of averages of waste was arrived at in a very fair way. It was taken in this way—the waste of water at the weir was taken at twelve o'clock each day for an hour; it was the same mode as taking an increment, which was universally applied in gauging streams, &c. It cannot be quite correct, but it is as likely to be wrong on the one side as on the other and no mortal man can tell on which. It may be that some floods escaped and would not be entered at all, because they occurred before twelve o'clock in the day, while others would be over-represented, the flood occurring at twelve o'clock being given as occurring all day. These results are entered in Mr. Cameron's water register. The average for the year 1869, calculated on a population of 216,000, was 37·16 per head per day, including the supply for all purposes. It is the want of reservoir accommodation that causes the waste. If we had had the means of storing it the water would not have been wasted. There are months when there is not a drop of waste. It is not continuous. It is the overflow which causes the waste. The greater proportion of the water at the Pentlands is pure. Compensation for the millers at Glencorse is provided by the company's Act of 1854, at the rate of 220 feet per minute.

Cross-examined by Mr. DENISON: In 1854 I gave evidence that the water in the Harlaw reservoir and the Danelaw was always brown. Those places are on the north side of the Pentlands. In 1869 we rejected all fittings that caused

waste, but we did not prescribe others. We were, in that year, proposing to spend £200,000 upon a new supply, because we had no power to check the waste.

Re-examined by Mr. WILL: The Edinburgh people are having continually to renew and repair their fittings. By economizing the water by preventing waste, the landlord would be paying practically less for his water supply, because he would avoid the necessity of bringing an additional supply.

By the CHAIRMAN: With regard to the overflow of the Glencorse waste weir, the waste was taken and entered there day by day, as the overflow occurred, during the whole period of my management of 25 years. There is a certain quantity of water overflow, more or less, every year. I believe there was only one exception, and that was last year. It would be physically impossible, that there should be 4 million gallons of waste.

Dr. *William Pole*, examined by Mr. WILL.

I am a civil engineer, a fellow of the Royal Society, and was secretary to the Royal Commissioners appointed to inquire into the water supply of large towns. I have directed my attention extensively to the subject of water supply. I was appointed by the Government to report on a proposed constant service for London last year, and in the course of my inquiries I directed my attention to various towns, to ascertain the quantities of water used, and, in cases where constant service was given, to inquire what measures were taken in those towns to keep down waste. I visited Norwich in December last, and found the consumption of water about 13 gallons per day by each person, though the authorities stated it was rather more. The company put the premises at my disposal for 24 hours. The result was that I found water had been running off to the extent of 911,000 gallons, the number of the population being 68,800. There were used for domestic purposes 10·8 gallons; for the trade and other purposes, 3·7; total, 14·5. I was surprised at the smallness of the consumption, and took means to test the accuracy of the figures. The people were satisfied with the supply, and with the control exercised over them. I have also visited Manchester, Sheffield, Liverpool, and Leeds, in each of which towns there is a constant supply, and measures have been adopted to check waste. I have reported favourably to the Government that, where control is exercised, waste can be prevented under the constant service system; and I have come to the conclusion in my own mind that, unless there is some exceptional reason in any particular town, waste can be controlled. The control consists in seeing that the lead supply-pipes are of such strength as to prevent the liability of bursting, that the joints are made so as to prevent leakage, and that the water-closets are provided with a simple apparatus to check waste. I ascertained that in Manchester, where the management is strict, but where the fittings are not so thoroughly revised and altered as in Norwich, the domestic supply is 14 gallons; trade, 7 gallons; total, 21. In Leeds I found both the regulation and management less strict, and there the domestic supply is 18·5; trade, 4·5; total 23. In Liverpool also the management is less strict, and there, with 12 hours service, the domestic supply is 21·5; trade, 4·6; total, 26·1. In Sheffield, where the regulations have only just been completed, the domestic supply is 26; trade, 3; total, 29. I do not know anything about Edinburgh, but I should say about 25 gallons would be an ample supply, if proper expedients were adopted to prevent waste, unless there are special circumstances of which I am not cognizant.

By the COMMITTEE: The conclusion arrived at by the Royal Commission was favourable to the supply being put in the hands of the corporations. I could not obtain positive information upon the point of how these stringent regulations worked in Manchester since they were put in force.

Dr. *Charles Bell*, examined by Mr. WILL.

I have written several works and papers in connexion with my profession. I know the St. Mary's Loch district pretty well, and have had good opportunities for judging of the quality of the water. I consider the water decidedly bad. My attention was particularly drawn to it this day week, when I drove along the margin of the loch, and was particularly struck with the two distinct colours which the water displayed—one was a brown colour, the other (nearer the shore) was clearer. I could not understand why there should be a distinction, and I resolved to satisfy myself. I proceeded, therefore, to examine what was the cause of the brown colour. So long as the water was undisturbed, it took the form of a slimy, stagnant water, but when disturbed it formed a cloud which prevented my seeing to the bottom. Moreover, the stones were covered with a sort of white slime, which seemed to be composed partly of decayed vegetable and partly of decayed animal matter. I think the water is bad for domestic consumption. I know Tibby Shiels perfectly. She does not drink the loch water in summer. She told me so herself. She has got a spring. I know both the Yarrow and the Ettrick. I have seen the mill-lade at Selkirk below the junction of the two streams, and I have seen all the water in dry weather going down the lade and not going over the weir. I can testify to animalculæ being in St. Mary's Loch water, and I can produce specimens which I took out of the loch myself when wading. [Bottle handed to the committee.] I should consider it very dangerous to drink the water containing these fleas, because, if they can live so long in a glass bottle, it indicates that they could live in the human system, and create a great amount of irritation, which I have no doubt would lead to the most serious consequences. It is a well-ascertained fact in medical science that some animals will live in the human system and produce the most dire results. These are water scorpoins [pointing to the bottle]. They inhabit stagnant water. I have shown these animals to a great many physicians, and they look upon them with horror and disgust, and say we should not drink such water. I have read in an account of Selkirkshire that the locality is liable to the visitation of a kind of grub or caterpillar, which animals appear in such manner that they choke up the pipes and springs.

Cross-examined by Mr. DENISON: I filled the bottle which I have produced in the upper part of the loch. I got it by wading up to near the knee. I never tried the same experiment in any of the existing reservoirs.

Mr. DENISON: Dr. Baird says that animals abound in muddy and stagnant waters, and also in clearest streams. What do you say to that?

Witness: It is quite possible, but I should not like to drink the water.

Mr. *Thomas Field*, examined by Mr. RODWELL.

I was formerly a member of the Town Council. I was one of a committee appointed by the Trust to consider the estimates of Mr. Leslie and Mr. Stewart. I was inclined to trust Mr. Leslie's estimate more than the other. I consider the present water supply very unsatisfactory, but I am quite unprejudiced as to what source is chosen for a better supply. In my judgment, however, St. Mary's Loch is the most expensive and the worst of all the schemes I examined. I preferred the Heriot, as the cheapest and best. I object to the increased taxation which the St. Mary's Loch scheme will involve. That is my principal objection, and this opinion is very generally shared by the people. I do not think that the scheme has had the consideration from the trustees which it ought to have obtained. There seems to be a prejudice in favour of St. Mary's Loch on the part of the majority of the trustees. It was my opinion that they went headlong into the scheme, and what I have heard in this room during the last few days has confirmed me in that opinion. Details of the scheme have been kept back.

Cross-examined by Mr. DENISON: I ceased to be a member of the Trust in November last. I expressed dissent from the present scheme. I was in favour of Mr. Leslie as consulting engineer, but I objected to Mr. Stewart as resident engineer, because I thought that some of those who stood against him were better fitted for the situation. A friend of my own was better qualified—my brother-in-law, in fact.

(*Witness* was then cross-examined with reference to the meetings of the Trust, when the various resolutions respecting the St. Mary's Loch scheme were adopted, but nothing new was elicited.)

Mr. *John Towse*, writer to the signet, and a member of the Town Council, gave evidence of a similar nature to the last witness.

Mr. *John Muirhead*, examined by Mr. MACDONALD.

I am a member of the Town Council. Previous to the ward meetings last October I was not in possession of proper facts to form an opinion on the St. Mary's Loch scheme, nor were my constituents. I have had opportunities, both privately and in business, of meeting large numbers of the citizens. The general feeling of the people, excepting the members of the Water Trust, is against this scheme. The general ground of objection to the scheme is the enormous expense, and I for one believe that a better supply could be got near at hand. The ratepayers feel that they have not been sufficiently consulted. There is a universal desire on the part of the inhabitants to obtain an additional water supply.

Cross-examined by Mr. DENISON: My ward is Newington. I had forgotten that Bailie Cousin did address the electors at the ward meeting on the subject of St. Mary's Loch scheme, when I made some complimentary remarks in reference to the scheme. Bailie Cousin voted against the scheme afterwards, owing to the expense. After the election of the Town Council, three trustees were elected, but no one had any chance of being elected a trustee who was not in favour of the St. Mary's Loch scheme. That was the tyranny of the majority.

Colonel *Cowan*, examined by Mr. MACDONALD.

I reside in the neighbourhood of Edinburgh, and own between 7000 and 8000 acres of sheep pasture on the Pentlands. I have been elected member of Parliament for Edinburgh four times. I am one of the opponents of this bill. I do not know of any subject, whether of local or imperial interest, that ever brought forth such unanimous opposition. I move in all classes of society, and, except the bare majority in the Town Council and Water Trustees, I think there are few who support this bill. I should like to read a letter from the venerable Mr. Adam Black, my former colleague, expressing his views on the subject.

Mr. DENISON objected.

Cross-examined by Mr. DENISON: I presided at a meeting of the opponents of this bill. I am not aware that I ever took part in any discussion contrary to the old water company. I had nothing to do with the opposition some years ago. Two years ago, however, at a meeting of the Chamber of Commerce, I explained my views very strongly against this scheme. I characterized it as wild, gigantic, extravagant, unnecessary, and mad. I never was at St. Mary's Loch in my life, and I do no know anything about the water. I am convinced that a sufficient supply of water for Edinburgh could be got from the Pentlands. I am no engineer, but I have had a lengthened experience, and have also had a good deal to do with water.

By the COMMITTEE: The object of the water company has been hitherto to look out entirely for water from springs. The great reservoir of Glencorse (which was constructed simply for compensation) was a series of small springs. There were no large springs unappropriated on the Pentlands, but there were numberless small springs, the aggregate of which would give a large additional supply to Edinburgh. Mr. Bateman having secured a great loch for the supply of Glasgow, it was thought by the promoters of this bill that, in order to keep up the dignity of Edinburgh, and to maintain its rivalry with Glasgow, they must have a loch too.

The CHAIRMAN: You must not impute motives.

Witness: I know the country thoroughly, and a great deal more water of the purest quality might be got there by arranging to supply the millers from another source in the district. I was a promoter of the North Esk reservoir, which is one of a series proposed 25 years ago and that reservoir contains, I think, about 25 million cubic feet, being very nearly half of the contents of the great reservoirs in the Glencorse Valley. That reservoir was constructed for less than £13,000. I know it could be easily raised. It is a very substantial work; the embankment is most solid, and there is plenty of stone in the immediate neighbourhood. I may state that, as owner of a great part of the Pentlands, I have no wish to see my beautiful valley—the valley of the "Gentle Shepherd," as it is called—invaded by an army of navvies; but I would make any sacrifice in order to promote the comfort of the people of Edinburgh, to whom I am under greater obligations than I can ever repay.

WEDNESDAY, MAY 10.

Mr. *R. Wilson*, examined by Mr. WILL.

I am a chartered accountant of Edinburgh, and have been a member of the Town Council. I have thoroughly examined Mr. Cameron's statement of the anticipated expenditure of the water company. When I first came to Edinburgh, and for years after, the value of property was very much under what it is now. Building is very much over done, and I do not think there is likely to be any increase for a considerable time. There is a large number of houses unoccupied, and a large number of houses in the market for sale. An immediate fall of rents is universally anticipated in Edinburgh by the building trade, and out of it; and I believe that it is anticipated that there will be a very great fall in the value of property too. Edinburgh not being a manufacturing town, and being inhabited by the class of people that I know live there, I do not think that the population is likely to materially increase; at all events, not to the same extent that it has done lately; the increase in the population varies very much in extent at different periods. For instance, in the 40 years from 1831 to 1871, it has increased a little over 84,000 altogether, or an average increase at each census of 21 per cent. The regularity of the increase is not to be depended upon, and it is in that respect not for a moment to be compared with Glasgow. Assuming Mr. Cameron's calculations to be correct, and that the cost of the works will be £500,000, the increase on the rates will be 5d. in the pound on the occupiers of dwelling-houses above £5 of annual value, raising thus 4d. on the domestic rate, and a new rate of 1d. as a public rate, making a total rate of £5 8s. 4d. per annum on £100 rental, which forms a burden equal to a preferable mortgage of £135 8s. 4d. on every house rented at £100. It is proposed, at the end of 18 years, to commence levying a contingent-rate for a sinking-fund of 1 per cent. Supposing the works cost £500,000, a sum of £7200 per annum would be required to be provided; and supposing they cost £650,000, a sum of £8700 would be required, which, in one case, would require an additional rate of a trifle less than 2d. in the pound, and in the other case of very nearly 2¼d. That would bring up the domestic rate in the event of the works costing £650,000, to a rate of 1s. 5d. in the pound, which is more than double the present rate; or a gross annual water-rate upon a rental of £100 of £7 1s. 8d., which forms a burden equal to a preferable mortgage of £177 2s. 8d. Supposing the works cost £500,000, there would be a domestic rate of 1s., and a public rate of 1d., which brings it up to 1s. 1d. I do not believe that there will be that increase in the consumption of water for trade and manufacturing purposes that Mr. Cameron contemplates. There are mills, foundries, and works of various kinds, but these works are very generally supplied with water from the canal, or the water of Leith, or from private wells, or sewage water. Supposing the Pentland scheme is adopted, I consider that 1d. in the pound of an extra rate would be quite sufficient for the purpose of raising £200,000 required for that purpose, and assuming the water-rents to go on increasing as Mr. Cameron anticipates, that would be only for a temporary period.

Cross-examined by Mr. CLERK: In 1869 I came up to London as a witness on the part of the ratepayers, and my expenses were paid by the water company. I do not know whether the population of Leith has increased by 15,278 in 1871. compared with 9783 in 1861. Considerable building is going on at the west end

of the town. At Newington and Morningside a great deal of building also is going on at the present moment. I believe there is a good demand in certain districts for expensive houses. I have also heard it said that it is not very likely that any more sugar refineries will be established in Leith. I think the estimate of Mr. Cameron unreasonable, because I do not think he will get the amount he estimates from the domestic water-rate, or that he will get very much from the manufactories. I think the proposed increase in the rental is put at too high a figure.

Re-examined by Mr. WILL: I know, as a fact, there is a difficulty in letting house property in Edinburgh.

Mr. *Peter Miller*, examined by Mr. MACDONALD.

I am one of the bailies of Edinburgh, and am chairman of the Streets and Buildings Committee of the Town Council. Property has depreciated in value, and building operations are almost at a standstill. Builders are almost solely employed in finishing houses on hand. Looking at the increase of the population during the last 50 years, the future probable augmentation will not exceed 3000 a year.

Cross-examined by Mr. CLERK: I am not aware that 68 houses are at present building on the Heriot Hospital estate. In the last three or four years the increase of population has been much greater than it has ever been before.

Dr. *William Wallace*, examined by Mr. MACDONALD.

I am a Fellow of the Royal Society of Edinburgh and of the Chemical Society of London. I have examined the Loch Katrine water, and find that it acts energetically upon lead. When the water was first introduced it was harder than it is now. It has now come very nearly to its natural condition of hardness. I attribute the recent accession of hardness to the lime which has dissolved from the masonry work of the conduit, and from rocks over which the water flows. For the use of a town I prefer water in a moderate degree of hardness. I consider that when very soft water is kept in leaden cisterns, there is a risk attending its use. Hot water has a more rapid action upon lead than cold water.

Cross-examined by Mr. CLERK: I found the Loch Katrine water to have 8-10ths of a degree of hardness. I have not analyzed the St. Mary's Loch water.

Mr. *James E. King*, examined by Mr. MACDONALD.

In 1869 I estimated the cost for a new tunnel in connexion with the St. Mary's Loch scheme at an average price of £12 3s. 9d. per yard. That did not include a brick lining. Supposing half the tunnel to be so lined, it would cost £14 10s. per yard. I had the entire management of the construction of the Greenock Water-Works tunnel. It was 1¼ mile long with a 5 feet 5 inch section, running through trap-rock, and costing £12 10s. per yard. The St. Mary's Loch tunnel, measuring 6½ miles, with a 6½ feet section, would cost in comparison with the Greenock tunnel about £2 additional per yard.

Cross-examined by Mr. CLERK: Mr. Foreman was the engineer of the Greenock tunnel; my father was contractor, and I was manager.

Mr. CLERK: Your calculation is based on the belief that there is whinstone or trap-rock all the way from St. Mary's Loch to Edinburgh?

Witness: I have got a sample of the rock.

Mr. CLERK: Would you be surprised if you were informed that there is not an inch of trap-rock between Edinburgh and St. Mary's Loch?

Witness: I should; but at present I am going on Mr. Leslie's information.

By the COMMITTEE: In making the tunnels, we drove our headings on each way and we had surfaces going. We progressed better with manual labour than with machinery. We tunnelled less than three yards a week.

J. R. Forman, Esq., C.E., examined by Mr. MACDONALD.

I am engineer of the Greenock and various other water-works. I have visited St. Mary's Loch, and estimated the cost of the works to be constructed for the scheme now being promoted. I had some difficulty in estimating the cost of the works not shown on the parliamentary plan, but I also had Mr. Bateman's estimate in view. My calculation is that £665,000 would be required for the works necessary for the supply of 12 million gallons, and that estimate includes filters, as I consider them absolutely necessary. I am quite satisfied that the works would cost the sum which I have estimated. I have just completed a tunnel at Greenock, for bringing water from the river Greave, and it is about 2600 yards in length. It goes through a mountain, and, of course, the accumulation of water is very much above, whereas in the present case it goes a good deal up from the centre of the valleys, and I think there would be more water on that account, as well as from the extended length. I was unable to come to an estimate of the cost of the works at the outlet, as I had no borings to show the material around the loch, and no plans to show correctly the works which were intended.

Cross-examined by Mr. CLERK: Greenock is the only place where I have tunnelled for water supply. We had to go through whinstone, which, although it is a hard rock, cuts clean. I have no detailed estimate of the present scheme. I do not know that my estimate exceeds Mr. Leslie's. I have taken the tunnel at a uniform price throughout. About half of it is sandstone. The first 7½ miles of the Loch Katrine works cost £23,000 a mile. I cannot say whether the St. Mary's Loch tunnel strata would be as hard as the Loch Katrine. My calculations as to the cost of the St. Mary's Loch tunnel are based on the supposition that the strata is whinstone. I cannot pretend to go into geology. I calculated £194,271 for tunelling, and £161,920 for piping (including jointing and laying), in my estimate for the St. Mary's Loch.

Re-examined by Mr. MACDONALD: There is no land included in my estimate.

Mr. CLERK here stated that Mrs. Ann Scott, of Rodons, had retired from the opposition to the bill, having accepted the same terms as the other landowners.

Allan D. Stewart, Esq., C.E., examined by Mr. WILL.

I am a civil engineer in Edinburgh. I was engaged on behalf of Mr. Dundas, of Arniston, in the Musselburgh and Dalkeith scheme. He is proprietor of the land on which the reservoir near Rosebery was placed. The quantity of water given by Parliament to Musselburgh is 83¼ cubic feet per minute, or 750,000 gallons per day. The area of the South Esk is 7500 acres, from Gladhouse Burn to Rosebery.

Mr. WILL: How much water is left in that district available for supply?

Witness: If properly utilized, it would give 14 million gallons per day for Edinburgh. There is no difficulty in laying out a scheme which would provide, from the sources of the South Esk and its tributaries, from 12 million to 14 million gallons per day. That would be 48 gallons per head of the present population. I examined the whole district, and about two years ago I suggested a scheme by which 8 million gallons could be brought into Edinburgh very economically from the upper water of the Gladhouse Burn and the upper water of the Fullerton, including part of Moorloch and the upper water of the Tweeddale Burn. I took a rainfall of only 18 inches, but I think that a very moderate allowance. I proposed to give compensation below. I made the inspection in connexion with Mr. Boarch, the civil engineer, and our estimate came to £175,000, allowing an ample margin for compensation. We communicated the result of our investigation to Lord Provost Chambers.

Cross-examined by Mr. CLERK: We did not offer our scheme to the Lord Provost. We wrote him a letter, telling him we thought the scheme was better for the town than the one published. This area, which is 7500 acres, is the drainage of the Temple water and the Gladhouse water alone, from Rosebery to its source. The proposed reservoir for the Musselburgh and Dalkeith scheme is situated on that stream. The drainage area I proposed is not within the drainage area of the Musselburgh scheme. I have made no water-supply works, except those at Leverton—a small place in the immediate suburbs of Edinburgh.

Thomas Hawksley, Esq., recalled, and examined by Mr. WILL.

I have considered many sources of supply in the district of Edinburgh, and intermediate between Edinburgh and St. Mary's Loch. The most available scheme is that of South Esk, and that system would give more than 9 million gallons, less three-quarters of a million given to Dalkeith and Musselburgh, which would be equal to 8½ millions, clear of any claims for compensation. The compensation has to be given from an adjoining watershed, which is much larger than is necessary for the purpose. Then a little more to the east there is another large watershed, also within the basin of Edinburgh, which could be made use of in addition, and that would give about 6000 acres more. For the sake of perspicuity, I will call this the Middleton district, because the principal burn is so named. This district would be available for supply and for compensation. Its value for Edinburgh would be about 5 million gallons per diem, so that these two alone would produce about 13 million gallons per diem—a quantity, of course, which would never be required. Then, south of that there is a very important area—namely, that of the river Heriot. That produces exceedingly fine water, and has within it very excellent basins suitable for reservoirs. Then, again, at the west end of the Pentlands there is another drainage area, additional to the 36,000 acres, of about 6000 acres. That is the Lyne district, producing also very good water, but shedding to the Tweed, which would make it necessary for a third of its area to be given up for compensation purposes There would be 4000 acres available. The fact is, there are almost too many sources to choose from. In 1869 I reported to the water company that their existing works were then capable of supplying more than 40 gallons per head daily, and that with the aid of some additions 50 gallons per head could be got, which was more than double the quantity that experience had proved to be necessary, and I advised that the fittings should be put in order. In one portion of these reports I referred especially to the schemes I have now been speaking of. My opinion was that these sources should be utilized before they went so far as the Tweed, much less St. Mary's Loch; because, apart from the genuine principle that you should exhaust your own immediate resources before you poach on another manor, they had the advantages of good quality and a small outlay, and the capability of a further supply being acquired as occasion for it might arise. The very interest saved during the number of years which must elapse between the making of one reservoir and another will make the reservoir. I also reported as to the Moorfoot or South Esk scheme, and stated that on the most moderate computation the Moorfoot district would augment the company's present means of supply by about 20 gallons per head per day, which is a superabundant supply for three times the present population, at a cost of about £200,000, and this has been confirmed by subsequent inspections. The cutting off of the supply for Musselburgh and Dalkeith will not interfere with a large and abundant supply of water from the South Esk for Edinburgh. There are over 9 million gallons, and all Musselburgh and Dalkeith get is three-quarters of a million. Above the compensation reservoir which is proposed on the South Esk, and which is consequent upon the abstraction of water from the stream by the Dalkeith and Musselburgh Corporation, there are sites excellent for two reservoirs, one being at Gladhouse. If the Edinburgh Trustees adopt this source they will have to give a supply of 750,000 gallons at this reservoir to Musselburgh and Dalkeith, and keep all the rest themselves. The compensation reservoirs made either on the Fullerton Burn or the Gladhouse Burn would give the water necessary to keep the milla on the rivers in operation. I am the consulting engineer of the Musselburgh and Dalkeith authorities, and I know this arrangement would suit their purpose well. It is not desirable for small communities, except in exceptional circumstances, to make works of their own; 8½ millions would be equal to 34 gallons per head per day to the present population. The estimated cost was £195,000; but I am not sure whether there were not some items that brought it up to £205,000 or £210,000. The 34 gallons would not all be required just now; but if they were to go for that scheme, it would not be prudent of them to take only a part of it. They would have to lay out only £200,000. The Fullerton Burn is peaty, and sometimes runs down very brown. I would run it into a separate reservoir for compensation purposes—that is, compensation to the river, not compensation to private individuals. There is no engineering difficulty in the way of carrying out the South Esk scheme, and there is abundant ground for reservoirs and storeage for at least 180 days, which is the proper quantity when the available water is 20 inches per annum. In some cases there is considerable difficulty in separating the peaty water from the clear water, in other cases very little. The Gladhouse Burn water is so good that I have no doubt that in conjunction with the existing water of Portmore Loch, which is situated in the drainage area, it would give water to Edinburgh just as good as that which is derived from the Pentland. The Heriot supply, although obtainable, could be of no use until the good water of the immediate watersheds of Edinburgh is exhausted. It seems to me improper to go into the Tweed district, as the waters are used at Galashiels on one stream, and at Selkirk, Innerleithen, and other places, or other streams or tributaries. The South Esk scheme would give 34 gallons per head per day, the Heriot scheme 40 gallons, and the Middleton scheme 20 gallons; but the very suggestion of these figures opens up the question as to what you would do with the water when you got it to Edinburgh. There would be no difficulty in taking water from these districts in connexion with the town of Galashiels except as to the Heriot. The Heriot goes down to Galashiels, and supplies the mills; and the people there would, of course, have a *locus standi* in any bill that might be introduced, but I have taken this into account in making my statement. I have been at St. Mary's Loch several times. Mr. Stewart's estimate does not include what I call contingencies, nor the great cost that must follow the introduction of the water. Then the water is utterly unfit for distribution without filtration, and even filtration will not remove its dark colour. The cost of filtration is always heavy; and here the difficulty of determining the cost arises from the unknown quantity to be dealt with. If they are going to introduce these enormous quantities, the cost of filtration will be enormous too. In the capital it costs about 50s. to filter 1000 gallons per diem. Then in working expenses, if things are economically managed, it costs about an eighth of a penny more, or in all, for 12 million gallons, something like £60,000. In addition to this there would have to be a large expenditure for distributing the water when it got to Edinburgh. I have no doubt altogether, that if this scheme were gone into, it would cost the community about three-quarters of a million to get the 12 million gallons, and that added to the present cost, which is at least as much, would make the total cost about a million and a half.

Mr. DENISON: You were one of the witnesses in the Musselburgh and Dalkeith Bill, and I think you told me that the towns had repudiated the idea of supplying these places with water?

Witness: Nothing of the kind came from me.

The CHAIRMAN: The question that was asked was whether there would be any difficulty in supplying these places from the Edinburgh supply, and the answer was, "No physical difficulty, but an absolute legal difficulty."

Mr. DENISON: Suppose you succeed in persuading this committee to take your opinion in preference to these other engineers, how would you succeed in getting your view carried out, because the trustees are still stupid enough to differ from you.

Witness: There is only one way of getting the water, and that is by an application to Parliament.

Mr. DENISON: But suppose the Trust say they will not have it.

Witness: They must do what is always done.

Mr. DENISON: And what is that?

Witness: Bow to the dicision of Parliament, and if Parliament says they have been injudicious or otherwise, they must submit.

Mr. DENISON: But the mischief is, you have no alternative scheme?

Witness: I will engage in three years to stop as much waste as will enable them to go on for that period, and to make three successive applications to Parliament if they like.

Mr. DENISON: The Galashiels gentlemen said the people of that town would fight to the last for keeping the floods down the Gala water.

Witness: I cannot speak for gentlemen who gave rather extraordinary evidence. I do not know that Mr. Stewart in his evidence stated £18,000 as the probable cost of filtration. At any rate I do not think that sum would do it.

By the COMMITTEE: There are 9 million gallons of pure water to be obtained from the South Esk, less the three-quarters of a million that have already been alienated by this committee.

THURSDAY, MAY 11.

Serjeant SARGOOD addressed the committee this morning on behalf of Messrs. Brown and Co., extensive millowners on the rivers Yarrow and Ettrick, at Selkirk, where they carried on the business of woollen cloth manufacturers. The question, he said, was one of the most vital importance to them, as it affected the carrying on of their business. Messrs. Brown were the heritable proprietors of the Ettrick works, the area of ground covered by which extended to upwards of eight acres; they had the property of the mill-lade or dam by which the whole water supplied by the Ettrick would lead to their works, and they had full possession of the privilege of taking by that lade or dam by a charter ratified by the Scottish Parliament. The claims of the millowners of Selkirk had been introduced to the committee by the promoters of the bill as if they were only concerned with the question of compensation, and as if those millowners on an ordinary stream merely enjoyed what might be called their normal rights and privileges; and the calculations for the compensation to them had been made on the ordinary basis that they were gaining an advantage on the river from its normal state, and had no right to more than they thus enjoyed; but the peculiarity of his clients was that they were in possession, by their own arrangements and by permission of the owners of the water, of what for the purposes of his argument he might call compensation, already—that was to say, that they already possessed provision against that which any third party obtained leave to abstract, and compensation in the nature of a provision against that abstraction which in the ordinary course of nature would always occur in places of that description, and which would create great inconvenience to millowners; and which, therefore, necessarily compelled them, as far as they could, to provide against it. His clients were in possession of a means of providing against it, for by the permission of Lord Napier (the owner of the loch) they had been allowed, at great expense, to erect a sluice and dam at the loch in order to regulate the amount of water, and by this means they were accommodated by a much larger proportion of water than would have been their natural supply but for that outlay. They employed a capital of £100,000 in their business, and afforded work for upwards of 600 people; and though he did not contend that they were entitled to any extra right on that account, he quoted those figures to show the importance of their work, and the disastrous effect upon a large working population which might be produced if the motive power of the loch were to be interfered with. Power was proposed to be conferred on the promoters to construct works on the river Yarrow, and to appropriate or submerge, *inter alia*, the sluice and aqueduct, and to dam up and withdraw 24 million gallons of water. Now the existing supply was absolutely essential to his clients, and the quantity of compensation proposed to be given to them was wholly insufficient. They complained very much of the 15th clause of the bill, which provided that the compensation to be given to them, small as it was, should be accepted by them for all time—that was to say, that while the promoters might come and get all they could out of the loch, Messrs. Brown and Co. should be bound to receive no more than 15 gallons per day, and should have no *locus standi* to come here again in case of any demand on the part of the promoters of the bill. In other words, the Messrs. Brown were to be compelled to take the minimum compensation and never to have it increased, whatever the wants of Selkirk, its manufactures, its millowners, and its corporation, might be in years to come.

The CHAIRMAN asked whether an amendment of the 15th clause would meet the learned serjeant's views.

Serjeant SARGOOD said it certainly would not. His clients went against the preamble of the bill. What they really desired was to stop this scheme altogether. The commission of 1869 laid down the broad principle that no town should seek its supply from a source which was within the geographical district of any other town unless under special circumstances. The proposition of the Edinburgh people in this case was to come into the Selkirk district and supply their city with water, and that proposition seemed to him to be in utter defiance of every one of the propositions contained in the commissioners recommendation. The promoters said nothing at all about any project to supply any place along their line, and the committee themselves would be able to judge whether there were such special circumstances which should alone justify parties in coming out of their own watershed and abstracting the water from others who had a more natural claim to it. After commenting at some length upon the evidence in support of the bill, the learned counsel concluded by saying that the promoters proposed to erect works and keep up the level of the loch at a particular height, and by that means they would effectually destroy the power of his clients to compensate themselves for the loss caused by the operations of nature. He submitted that that was the spirit of the bill. If the wants of Edinburgh did exist, they existed through the negligence and carelessness of the promoters themselves, and he said that they would exist until that negligence or carelessness was effectually stopped. If the committee thought that the view of his clients which he had placed before them was justified in theory and in principle, and by the evidence submitted, he trusted that they would throw out the bill by declaring that the preamble was not proved.

Mr. *William Brown*, examined by Mr. MACDONALD.

I am senior partner in the firm of William Brown and Co., the joint proprietors of the Ettrick Mills, and I have been engaged in manufacturing there since 1837. The property was acquired from the burgh of Selkirk, and we had a formal grant through the burgh, under a royal charter, of a right to the stream, with a fall of 7 feet. We have £100,000 of capital invested in the business, and we employ 600 persons. The value of our works—buildings, machinery, &c.—is upwards of £50,000; the machinery connected with the water power cost about £6000. We supplement the water power by the use of steam when necessary. The water power is very useful at night in preventing the employment of the steam-engine. We can use all the water that runs in our lade, when it is full, by our present wheels, and we have an empty wheelhouse ready for the erection of another wheel when the works require it. We have a full lade three-fourths of the year. I have seen the water on one or two occasions reduced to one-third, but the average quantity we have during the remaining three months of the year is about one-half. The descent is gradual. It is never low for any considerable period except in very dry seasons, such as the last two years have been. When the water falls below the average, we go to the sluice at St. Mary's Loch, which we have had since 1844, by the permission of Lord Napier. There has been no interference on the part of any one with our power to use the sluice since we had permission to make it. If we were not to get the benefit of the sluice, which we have hitherto had, it would seriously affect our works and cost us very much more expense. It would lessen the mill-lade, and we should require to use more steam. The water coming down the river is available to us for other purposes besides motive power. We use it for scouring and washing, and for condensing water, and for the steam-engine. It is important for carrying on our business successfully that our supply of water should not be reduced.

Mr. DENISON: Especially in summer, I suppose, when it is sometimes very low.

Witness: Yes.

Mr. *Simon Bathgate*, examined by Mr. MACDONALD.

I have been an engineer in Selkirk for about 33 years. I am well acquainted with the locality, and with the water supply of Selkirk. There is a cauld across the river at the upper end of the haugh for the purpose of turning the water-works of the commissioners. A considerable amount of power is required for pumping up water for the use of the town, the town being situated on an eminence, and the river lying much below its level, so that the water has to be forced up into a reservoir above before it can enter the distribution-pipes. The burgh let their corn and flour mills. When there is not a large amount of water, the mills get the use of the water by day, and the commissioners use it by night to drive the pumps. Many years ago, in consequence of an application to Lord Napier, a sluice was erected at St. Mary's Loch to supplement the water supply. I made a survey, and prepared the plans for the works, which were executed in 1845. Since then there has been a supply derived from that sluice whenever it was thought necessary for the purposes of the mills. There has been no objection made by any one to the use of that sluice. The mill-lade in its present state has 26 feet of clear width, and it is capable of passing 12,000 cubic feet per minute, or 108 gallons per day. That is rather more than the mills can use at present advantageously, and therefore the sluice is regulated to bring in about 90 million gallons per day. There is a full lade about six months in the year. I estimate a full lade at 10,000 gallons a minute. It may run from that to 6000 cubic feet, or 54 million gallons a day for from three to four months in the year. I suppose it would be running for two or three months from 6000 cubic feet down sometimes to as low as 3000 cubic feet, which would be 27 million gallons. It very rarely is so far reduced except when the water is drawn from the loch, and no rain falls to keep up the supply. The population of the burgh is 4640, and the valuation roll of the property is upwards of £12,000. I am a town councillor and a commissioner of police. The sluices were made from my plans, and, along with Mr. Leech, I have measured the outflow of the loch through the sluices. This was in 1869 and 1870, after we had heard there was a scheme to take the water of the loch to Edinburgh. These years were generally dry years. On the 13th of July, 1869, we measured the flow, and made it 2943 cubic feet, or 26,487,000 gallons per day. On the 22nd of July it was 2478 cubic feet, or 22,302,000 gallons; on the 12th of August it was 2292 cubic feet, or 20,628,000 gallons; on the 26th of August it was 1690 cubic feet, or 15,210,000 gallons. These were all the measurements we took in 1869. In 1870 our first measurement was taken upon the 2nd of August, and the flow from the loch by the sluices was then 4130 cubic feet, or 37,170,000 gallons per day. I may mention that the sluices had been lifted some days previously, and there had been a fall of the water of the loch of fully 6 inches. On the 20th of August the flow was 1660 cubic feet, or 14,940,000 gallons; and on the 3rd of September, 1721 cubic feet, or 15,489,000 gallons. That is an average flow of 2460 cubic feet, or 22,152,250 gallons per day. The compensation offered by this bill is not sufficient to put the mills in the same position as they are now—very far from it. In fact, I have no doubt the effect of this bill would be very disastrous to the supply of water to Selkirk.

By Mr. ALEXANDER: Previous to 1865 Selkirk was supplied with water from the roofs of the houses, and from private and public wells. The corporation then adopted the Police Act, under which they made arrangements for a supply from the mill-lade. The water comes down the lade that drives the water-wheel; the water-wheel is connected by gearing with the pump; the pump draws the water from the well, and forces it up to the town reservoir for supply and distribution about 330 feet above the level of the collective well. It is then distributed from the reservoir to all parts of the town where it is required by a separate pipe from the ascending-pipe. The population is almost entirely dependent on that supply. The present assessment for the water-rate is 1s. 8d.; last year 1s. 7d. If the compensation at Yarrow were limited to 15 million gallons per day, the effect would be that we should not get the pumps to go every day; and in that case it would be difficult to get water without the aid of a steam-engine. The quantity now is about 45,000 gallons, or 11 gallons a head per day. The inhabitants of Selkirk have found that a very great boon, and sufficient for their domestic wants. At the same time, I may say that water-closets are not so common in Selkirk as they might be if there were more water.

Cross-examined by Mr. DENISON: Twenty gallons a head would be a very good supply, seeing that we use only 11 gallons at present. That would be 92,000 gallons. We use 15 million gallons for power to send up the supply. It requires 10-horse power 10 hours a day to lift our present supply. I believe the Selkirk drainage area is the Ettrick and Yarrow district. The drainage area of St. Mary's Loch is about 28,000 acres. It is about 16 miles below Selkirk. We get from St. Mary's about two-thirds. I have not calculated what fraction of an inch over 117,000 acres would produce 90,000 gallons.

Re-examined by Serjeant SARGOOD: We do not get our water out of the river, but out of the wells, and we get it by using the water in the mill-dam which comes from the river, so that if we do not get sufficient force for pumping we should not get our proper supply. The well is important for the domestic supply, and the mill-lade is important for the motive power in pumping up the water.

Mr. *George Romans*, examined by Serjeant SARGOOD.

I have practised as a civil engineer at Edinburgh for about eleven years, during which period I have been more or less engaged in connexion with water-works. I have examined the Selkirk district, including Mr. Brown's works, and I have considered the subject of compensation. In this particular case, the present value to the millowners of the St. Mary's Loch as a source of supply is the proper means of reckoning the compensation. The Yarrow at the outfall of the St. Mary's Loch is higher than the Ettrick. The average elevation of the St. Mary's Loch district is 1510 feet above the level of the sea. The per centage of the rainfall in the district, as compared with the rainfall on the whole of the Selkirk area, is about 32 per cent. I have made gaugings of the volume of the river Yarrow and of the river Ettrick. On the 27th of March last I estimated the overflow from St. Mary's Loch, and I found that it formed 35 per cent. of the whole water of the Ettrick at Selkirk. On the 8th of April I took another gauging, and found that the overflow from the loch then formed 42 per cent. of the whole of the water at Selkirk. There were 6821 cubic feet of water per minute passing down the Ettrick, which was not sufficient to give the average quantity required for mill purposes. The outflow from the loch was 2880 cubic feet per minute. The Yarrow, at the outflow of the loch, is not so much affected by wet weather as the rest of the river. The result of my calculations showed me that the average quantity of water flowing from St. Mary's Loch to Selkirk is 2592 cubic feet per minute, but I think the compensation given to Selkirk ought to be more than that; 2592 cubic feet per minute would correspond with a rainfall of nearly 14 inches over the district, and would be equal to 23½ million gallons per day. Some of the calculations with regard to the rainfall submitted to the committee by Mr. Bateman I have found to be inaccurate. The inaccuracy has reference to the height of the rainfall in the St. Mary's Loch district, which is really 4·6 inches higher than Mr. Bateman put it. The total average height of the rainfall was 63·3 inches at four stations where gauges were kept in 1870, and would represent 26,766,300 gallons per minute instead of 15½ millions. The average elevation of the stations of the gauges is 1·248 feet above the sea, and the average elevation of the whole district is 1·520, or 2·70 higher than the gauges.

The CHAIRMAN inquired what the object of this examination was.

Serjeant SARGOOD stated that it was to raise the rainfall from the amount at which it had been placed by the promoters to two or three inches higher than their own table.

The CHAIRMAN said that was not a question for consideration on the preamble of the bill, but would have to be fought out on the clauses.

Serjeant SARGOOD: That is my case.

Mr. WILL: I appear here on separate instructions from the Corporation and Police Commission of Selkirk, Messrs. George Roberts and Co., and Messrs. Waddel and Turnbull, manufacturers in Selkirk, and Sir John Murray of Philiphaugh.

Mr. *D. C. Alexander*, examined by Mr. WILL.

I am solicitor and bank agent in Selkirk, and valuation assessor for the burgh. The valuation is £12,020. The oldest charter of Selkirk (which is a royal burgh) is dated 1535, but the first charter affecting the water is a decreet-arbitral dated early in the 17th century. From time immemorial Selkirk has had a dam across the Ettrick, and the town has corn and flour mills of its own. It has, therefore, an interest in this bill as millowners. In dry weather there is a much larger body of water in the Yarrow than in the Ettrick. In the valley of the Ettrick there has been so much drainage for agricultural purposes that in dry weather the water runs off rapidly, and the river becomes very low indeed. Some years ago the Commissioners of Police resolved on obtaining a town supply, and they consulted Mr. Leslie on the subject. The population of Selkirk has increased during the last ten years 25 per cent., and the valuation has increased by £4970. The inhabited houses in 1861 were 421, and there are now 517, so that Selkirk has all the appearances of a flourishing town. Its prosperity is entirely owing to its manufactories, which have sprung into being within the last thirty years. About 1000 hands are employed in the mills. The town presents every aspect of continuing to increase, and is one of the most prosperous little towns in the south of Scotland. I am solicitor to Sir John Murray, who is proprietor of lands on the banks of the Yarrow and the Ettrick. He has a villa and mansion house which overlook the bed of the Yarrow. The diminution of the volume of water in the river would materially diminish the value of his property. He has mills on the river, and by a decree of the Court of Session in 1846 he acquired a right to construct a dam on the river.

Cross-examined by Mr. DENISON: The promoters of this measure never came to Sir John Murray, or the millowners or Corporation of Selkirk, to ask what they would take. Sir John Murray will be satisfied with what his engineer recommends—namely, 25 million gallons a day.

Mr. *James Roberts*, examined by Mr. WILL.

I am a manufacturer in Selkirk, and, with my partner, own the oldest mill in the town. I am a member of the corporation, and a commissioner of police. I concur in the evidence already given that a compensation of 15 million gallons for that now supplied by St. Mary's Loch would not be sufficient for our own manufacturing purposes. At present we are obliged to supplement the water power we have by steam power, at a considerable expense. In dry weather the volume of water in the Ettrick is very much diminished. We could not afford to give up the water which we obtain from sluices in St. Mary's Loch. The manufacturing interest in Selkirk is developing year by year, and is likely to continue developing for many years to come. We are enabled to utilize all the water we now get, and could utilize 90 million gallons per day.

Mr. *William Waddel* and Mr. *Leitch*, manufacturers, of Selkirk, were examined, and corroborated the foregoing evidence.

Mr. *Allan Stewart*, examined by Mr. WILL.

I am a civil engineer. I have measured the flow of water at Selkirk. I estimate it at 90 million gallons per day, and I believe about one-third of it (or 30 millions) is derived from St. Mary's Loch. I think the compensation (15 millions) proposed to be given to us is insufficient. It ought to be from 25 million to 30 million gallons a day.

Thomas Hawksley, Esq., recalled, and further examined by Mr. WILL.

I have specially considered this scheme with relation to Selkirk. The fair amount of compensation is 26,500,000 gallons, and 15 millions are proposed by the bill. By experience, at the commencement of a drought there is just about six times the terminal quantity of rainfall on the land. On the average of a long drought (not an ordinary one) there is about 1·29 comes off every 1000 acres of land. Now 28,000 acres (without allowing for extra rainfall or peat) give out 19 million gallons per day; the storeage would give 3,300,000 gallons per day more—making, together, 22,225,000 gallons for a period of long drought. But, in ordinary years, it works out to 28 millions. Reckoning a long drought, which may occur every fourth year, and for the three intermediate years only ordinary droughts, there would be three times 28 millions and once 22 millions. That would make the one-fourth of 106 millions, which is 26,500,000; and, in looking at the quantity which the millowners have actually drawn from the loch, I am quite sure that is a fair estimate of the value of the interest of the Selkirk millowners in the loch. Supposing the 15 million gallons proposed by the promoters be made up to the 20 millions requisite for Selkirk, then, of course, Edinburgh must have that amount less than it calculates on. I concur with the millowners evidence. The mill-lade is constructed to carry 120 millions, but the water-wheels at present erected will only consume 90 millions. More water could be utilized by the use of additional wheels. From 40 to 50 million gallons per day can be drawn through the St. Mary's Loch sluice. The 26 million gallons would, of course, be the perpetual flow to which the river interest would be entitled. It almost exactly tallies with the ordinary rate of compensation given. It is not at all a question as to one-third, of what has mistakenly been called "the utilized water." There is a great error upon that. The question in that case is, what is the proper amount to be given in compensation for the established interests? Where no water is impounded, it is there that we find that the established interests utilize for themselves, from the naked drainage-ground, about one-third of the water which comes off it, and therefore one-third is the proper quantity. The persons who come there take much or little; it is perfectly immaterial how much, because that is only compensation for the interest as it existed before the loch or the drainage-ground was touched at all. It matters not whether they take 1 gallon or 24 million gallons. The drainage-ground before they touched it afforded 26½ million gallons usefully, and three times 26½ million gallons, of which twice 26½ million gallons is not useful. It has nothing at all to do with the question as to how much the proprietors of the mills please to utilize. The Selkirk millowners are using the sluice of the loch, and the great advantage of their mode of using it is, that as the rivers fall off they can draw more and more up to a certain maximum. If the Selkirk people get their proper amount of compensation, it is quite immaterial as to the how or where it comes from.

Cross-examined by Mr. DENISON: The drainage area of St. Mary's Loch is capable of affording a supply of 19½ million gallons daily, one-third of which, in consideration of the established interests, ought to be given to Selkirk.

Mr. WILL then commenced his address on behalf of the Corporation of Selkirk, and observed that the issue raised in this part of the case he considered most important, being nothing less than an issue between Selkirk and Edinburgh. On the one hand they had a growing community—a prosperous town, whose manufactures had been rapidly increasing during the last thirty years, and whose inhabitants were largely dependent on these manufactures—a town where large sums had been expended on the construction of wells, and where the water had been extensively utilized. This being the case, he was quite sure that nothing would be done in that committee-room that would in any way prejudice the town of Selkirk, or interfere with the development of its manufactures, even for the purpose of giving a supply of water to Edinburgh of 50 gallons a day for a hundred years. The first issue raised was whether there was an abundant supply of water conveyed from the present sources of supply available to the trustees, and whether, in cases where want had been felt, it was attributable to preventible waste. On this point he was entitled to call independent evidence, but he thought sufficient had been said to satisfy the committee. The second issue was, whether, supposing the promoters had not sufficient water at present, they could obtain an abundant supply nearer home than St. Mary's Loch, and that at a smaller cost than by robbing the Selkirk people of what they considered their natural and legal rights. The issue was, in other words, the prosperity of Selkirk as against the whim of Edinburgh. Then there were other two questions raised. The one was as to the engineering details of the undertaking, and in connexion with this he submitted that the compensation to which the Selkirk people were entitled was 26½ millions, and that it was quite impossible for the promoters to supply that quantity with the works they proposed to construct, and at the same time to get their own supply. Lastly, he challenged the estimates on which the bill was based. It was for Edinburgh to show first of all that it was necessary they should have an additional supply of water; next, that they must have this particular supply of water; and, further, that they could impound it without injury to other localities at present dependent upon it. If ever Edinburgh were permitted to place its paw upon St. Mary's Loch, it could only be to the detriment of large and flourishing towns in the district to which it at present formed the only natural source of supply. Another ground for opposing the scheme of the promoters was the waste which now went on in Edinburgh. If a check were imposed, and the water supply were placed under better arrangement, he believed that the present sources of supply would prove adequate for the existing wants of Edinburgh. It was said that the waste in Edinburgh was unavoidable, but in other towns waste had been prevented, and there was no reason why similar measures should not be adopted in regard to Edinburgh.

FRIDAY, MAY 12.

Mr. WILL, in resuming his speech, said the town of Selkirk had, within the last ten years, greatly increased in population, rental, and otherwise; yet it was coolly proposed to deprive Selkirk of half the water it had at present, to stop its development, and trammel its trade, in order, forsooth, that certain fanciful persons in Edinburgh might be enabled to look forward for 100 years. In order to show the reckless way in which the scheme had been gone about, he might mention that the bill proposed to give power to sell the existing works—a proposal of which the Lord Provost was ignorant until his attention was called to it in that room, and which he then described as ridiculous. The wildness of the scheme did not stop, however, with what he had been describing, for the promoters actually proposed to take power to supply the whole world, if necessary, with water. Mr. Hawksley admitted the general accuracy of the estimate that Edinburgh could obtain a supply equivalent to 120 gallons per day per head from sources independent of St. Mary's Loch; but, supposing that estimate exaggerated the actual state of facts by three-fourths, and they could only obtain 30 gallons per day for each person, that would give, with the existing supply, 58 gallons per head per day. Next came the question of the comparative cost of the different schemes; and he would remark first, that, if the question rested upon this point only, it would be the first duty of the promoters of the bill to go to the Pentlands for the water, supposing the cost would be the same as that of going to St. Mary's Loch. When Mr. Bateman was asked to suggest a scheme of his own, he immediately suggested the Heriot; but when he came down and was asked to report upon the St. Mary's Loch scheme, his judgment was fettered. When unbiassed, the Heriot was the district to which he pointed. Mr. Leslie, in the suppressed report, stated that the collecting area of Moorfoot was 8200 acres, which would afford a yield of 9 million gallons per day, and would be equivalent to an addition of 36 gallons per head per day for the community of Edinburgh; but, as that was more than would be required at present, the Rosebery reservoir might be used also for a supply for Dalkeith and Musselburgh. Mr. Leslie estimated the cost of the scheme, including reservoirs and filters, at £225,000. It was worthy of observation that all the witnesses concurred in recommending that scheme, and nobody had ever suggested, until this inquiry was set on foot, that any serious objection existed to the scheme being carried out. What was wanted was a reasonable quantity of water for the reasonable requirements of the inhabitants, and not an expensive scheme, which seemed to have been adopted in the faith that the pockets of the ratepayers were practically inexhaustible. They professed to be in favour of a scheme which could be carried out at the least possible expense; and, applying that test to St. Mary's Loch, how did it stand? The committee must remember that the £480,000 was not the whole money that would be required in bringing the scheme into operation, but only the estimate of the cost of works. Three-quarters of a million would scarcely suffice as the total. Even supposing the committee were to refuse the supply from the Pentlands, the Heriot could yield 10 million gallons per day, or 40 gallons per head to the present population. Adding that to the other sources of supply, there might be a total secured of 122 million of gallons daily, representing a quantity sufficient for ten Edinburghs. It was generally admitted that Selkirk should be protected, and that nothing should be done which would injure its prosperity, because that prosperity was mainly dependent upon the water power of the mills and manufactories. On the question of compensation, he submitted that it should be determined on the principle of the extent to which his clients now enjoyed its use, and not on the quantity taken away; while another element for consideration was, that they were not here dealing with an ordinary stream entirely without natural storeage.

Mr. DENISON, on behalf of the promoters, said that of all the water opposition he had ever seen, that of Selkirk was the most extraordinary. They had a population of 4600. They were 16 miles below the loch, being very near the limit which would have excluded their *locus standi*. They had 117,000 acres of drainage, and they were getting 27 million gallons a day. Mr. Bateman had told the committee very clearly what compensation was to be offered them—viz., 11 million gallons in wet weather, or 20 million in dry seasons. They would thus be more advantageously situated than they were at present. As to the question of the sluices, that, too, had assumed a ridiculous character. Their only title was the letter from Lord Napier, saying they were to take what water they liked, he believing himself sole owner of the loch. It turned out, however, that his lordship had no power to grant that permission, and that the transaction gave them no earthly right, either temporary or permanent. The promoters had already suffered enough through this mistake in law and in fact, because in 1869 the St. Mary's Loch scheme was struck out of the bill on the ground that the consent of Lord Napier had not been obtained, and the committee refused to go on with it in his lordship's absence, and the part of the bill was thrown out for technical reasons upon the Standing Orders. Now, Lord Napier, and the other proprietors are consenting parties to the scheme. Passing to more general and important topics, he never remembered an opposition conducted as the present one had been. At a late stage of the proceedings the committee had decided that an abundant supply of pure water was necessary, in which the opposition acquiesced and stood still; while now their contention was that abundance was not wanted. Then, as to waste, their petition did not contain a word about that. He knew there was a deal of waste; but it must be recollected that this was a bill to serve the people of Edinburgh, and their only opposition was the ratepayers. If they were willing to come under the control of the Norwich people, why didn't they do so? Because they were not willing. In fact, it was found impossible to enforce such stringent regulations in Scottish towns as were imposed in England. All the talk about waste, however, had only been the invention of the professional scientific gentlemen examined on the other side, and did not emanate from the clients for whom his learned friend Mr. Will appeared. But what about the Pentlands? There was not a word in the petition about that either. That most absurd scheme was imported into the case at the last moment. The opposition had been obliged to get up this scheme, and resort to every kind of pretext and device for throwing out the bill. Their objections were cost, concealment of documents, fleas, lead poisoning, heavy rates, and public opinion. As to the division amongst the trustees, he reminded the committee that there was no such thing until Mr. Field failed in getting

his brother-in-law appointed engineer, and then suddenly came to think the trustees tainted with prejudice. What possible reason they could have for being prejudiced no human being had suggested. To come there and talk of men being prejudiced when they had been unanimous until a personal question arose as to the brother-in-law of one of their number, was a mere absurdity. But it was more than an absurdity; it was a thing that ought not to be done. Was there any suggestion that any single promoter of the bill, either professional, local, or anything else, had any reason for being in favour of the St. Mary's Loch scheme, except that in his judgment—which was not prejudice—he thought it the best? He had never heard of any. Since the agitation had begun against the bill, there had no doubt been a division in the Town Council about it, with not a very large majority, though still with a majority, in its favour. It must be recollected, however, that although Edinburgh was a large and important place, it was not the only place interested in this measure. Leith—no inconsiderable place—and Portobello were also interested, and, so far as they had heard, there had been no division in either of these burghs. The only division of any consequence was in the Town Council of Edinburgh, and that not till after the agitation against the bill had begun; so if they talked about public opinion, and looked at it in the only way it could fairly be looked at, he maintained that there never had been a case in which there had been greater evidence of a preponderance of feeling in favour of a scheme. How, then, did the agitation begin? It began by the letters of that anonymous and antiquated gentleman they had had before them—antiquated not only in age, for that would not have mattered, but antiquated also in his opinions, for Dr. Frankland had pointed out that the views of "A Physician" were twenty-five years behind the age. There was a period at which people did not rapidly take in new ideas. This period seemed to have been reached by the physician, and accordingly having got into his head that certain things were true about fleas, and rickets, and lead poisoning, he was very unwilling to believe that any of then might have been proved to be erroneous. One thing he believed the physician did not exaggerate, and that was the expense of parliamentary proceedings. He had pointed out in his first letter that an expenditure of £20,000 had been incurred in 1869, and there was no reason for believing that the figures were in any way exaggerated. This was important, because the trustees had to come to Parliament and fight these battles at an expense of £20,000, he was very sure of this, that if the committee had any doubt on this question, they would give the benefit of that doubt to the promoters, and not make it necessary for them to fight the battle over again, with the chance, after all, of not gaining their object. They had not their two rival schemes to choose between, and all the committee could do was to reject the present measure, and then, if the promoters afterwards adopted one of the other schemes, it would be with the certainty of another opposition. As to the manner in which the agitation had been got up, let them imagine a town of 250,000 people, with its walls covered with large pictures of fleas, and letters published in its newspapers threatening people with all sorts of evil results from using the water, and these letters increased in importance by the appearance of vast learning which the repeated quotations from continental authorities gave them—let them imagine this, and they would not wonder that a considerable opposition had been raised against this bill, although not one word had been said against it during the two previous years it had been before the public. Some people liked notoriety, and he dared say the "Physician" in his retirement might muse with satisfaction on the storm he had created, and might even flatter himself that he had raised as great a storm as Edinburgh was capable of. Having alluded to the opposition of the old water company, Mr. Denison combated the figures of Mr. Hawksley in reference to the cost, and pointed out that so far from there having been no discussion on the question, it had been before the public for two years, and at the elections of last November, nobody had been turned out in consequence of supporting the scheme. The ratepayers had actually been told in public that the contemplated expenses were as they had been estimated, and he would like to know what pretence any one could have for coming there and saying that the matter had never been discussed, and that it was not known what the undertaking was to cost. The committee knew that everything had been published with the exception of two documents, which had been withheld because they would give information, not to the Edinburgh people, but to the Selkirk opponents. All that the ratepayers had to do with was the expense, and he said emphatically that they had been informed of the worst that could be said on this subject, with the exception of Mr. Hawksley's exaggerated estimate. The learned counsel then referred to the subject of waste. He reminded the committee that waste meant two things. If a man burned two tons of coal where only one ton was required, the other ton was undoubtedly wasted, for coal was a valuable substance, and when once used it was done with for ever. It was different as to water, for, unless it happened to be required for some other specific purpose, what was called wasting it was merely sending it in one direction instead of another. The committee would remember what some of the witnesses, especially Mr. Chambers, had said about the closes and sewers of Edinburgh—the extreme "closeness," so to speak, of the closes—the occasional choking of the sewers, and the enormous height of the buildings. Now, sending water down these closes was certainly in one sense waste; and, if they were taking away the water from people that required it for drinking purposes, it would be indefensible waste. But they were not doing this, and the water, instead of being wasted, was being made to serve a useful purpose. The word "waste," in such circumstances, was inapplicable. It was simply a turning of water from a place where it did no good at all, into closes and sewers where it was calculated to benefit the public health. It had been demonstrated that more water was required. He did not dispute that they could do with less water than they asked for, but the habits of the people were such that they preferred to have an abundant supply, and even to pay a large sum of money for it; and, if such was the case, it was nobody's affair but their own. Having reviewed the steps taken by Mr. Leslie in advising the water company three years ago, the learned counsel proceeded to refer to Mr. Hawksley's evidence with regard to the Pentlands. There was a report of Mr. Hawksley's, that had been referred to over and over again, which had been made in 1868, and it was curious to look back on this document and see that he never at that time suggested the Pentlands. Not only had Mr. Hawksley never suggested them, but they had never, from the beginning to the end, been suggested as a practicable scheme by any one. That was a striking fact, and showed that the scheme was an invention. Mr. Bateman had dismissed the Pentlands scheme because he considered it the most expensive of all that had been proposed, and this view was borne out by the experience of the water company. Mr. Will had tried to insinuate that the engineer had received instructions from the trustees to report in favour of St. Mary's Loch, but the insinuation was one for which there was no foundation. There never had been a case in which there had been such an impartial inquiry going on. After referring shortly to the evidence as to the quality of the water, the learned counsel proceeded to speak of the estimates, and said that Mr. Bateman's summary of costs had never been questioned. This summary estimated that the Heriot scheme would cost £34,000 per million gallons; the South Esk, £30,000; and the South Esk with the Fullerton Burn, £29,000; being an average for the three of between £31,000 and £32,000. This was exactly the same as the first instalment of the St. Mary's Loch scheme would cost; but, if they looked 15 or 20 years ahead, to the introduction of the second instalment, the average of this scheme would be reduced to £22,750. He was willing to take the cost roughly at £500,000, and allow any reasonable margin that they liked, and still it would be found that the St. Mary's Loch scheme would be enormously the cheapest of all that had been proposed. The learned counsel concluded by alluding to the difficulties the promoters would probably meet with if the bill were thrown out, and they attempted to get a supply of water from any of the other sources that had been spoken of.

The room was then cleared. After the committee had deliberated for some time, counsel and parties were readmitted, and

The CHAIRMAN said: The committee, after very carefully considering all the evidence that has been adduced, are of opinion that the preamble is proved.

Serjeant SARGOOD: With regard to Messrs. Brown's petition, your lordship will be kind enough to allow me to say that we retire.

The CHAIRMAN: Very well. Then we will consider the clauses on Monday next.

MONDAY, MAY 15.

Mr. HOPE stated, on behalf of the Duke of Buccleuch, that as the preamble of the bill had been proved, his grace would reserve his opposition for another place.

Mr. CLERK stated that his clients were quite prepared to meet what they understood to be his grace's view in regard to the minimum quantity of water discharged down the river, and that instead of 15 million gallons it should be 17 million. They were willing to insert that in the bill.

Mr. GRAHAM said he had a letter from the Selkirk people intimating their withdrawal from opposition to the bill, so that all the parties had now retired. He supposed the object of their not going into the clauses was to reserve their opposition for the House of Lords.

The clauses of the bill were then proceeded with without opposition, and the chairman was directed to report the bill, as amended, to the House.

Miscellaneous News.

RATCLIFF GASLIGHT AND COKE COMPANY.

The Half-Yearly General Meeting of the Shareholders of this Company was held at the Offices, 345, Cable Street, on Thursday, Aug. 31—ANDREW WILSON, Esq., in the chair.

The SECRETARY having read the advertisement convening the meeting, the seal of the company was affixed to the register of shareholders, and the following report and statement of accounts were presented:—

The directors have much pleasure in submitting their report and accounts for the half year ended June 30, 1871.

The accounts have been duly examined and certified by the auditors.

Out of the available balance of profits, the directors recommend that a dividend upon the paid-up capital of the company, after the rate of 5 per cent., for the half year ended June 30, 1871 (less income-tax), be now declared, payable on and after the 4th day of October next.

Trade Account, for the Six Months ended June 30, 1871.

Dr.				*Cr.*			
To Coals			£6,600 14 6	By Gas			£14,966 19 6
Purifying materials			204 10 11	Public lighting			1,972 6 6
Salaries of engineer and clerk at works			285 10 0	Rental of meters			48 18 7
Wages			1,856 18 11	Coke, less breeze loss, £20 12s. 3d.			2,585 15 9
Repairs & maint. of works & plant, & labour £1692 17 10				Tar			242 6 6
Less old matrl. sold 138 5 3				Ammoniacal liquor			669 7 5
			1,554 12 7	Miscellaneous receipts			91 4 5
Salaries of inspectors and clerks in office			310 10 10				
Repairs and maintenance, distribution, and labour			1,318 17 1				
Wapping wall accident—"Oliver v. the Company"			617 17 6				
Repairing and renewing meters			282 18 7				
Lighting and repairing public lamps			311 14 4				
Rents			130 8 4				
Rates and taxes			531 11 1				
Directors allowances			400 0 0				
Salaries of secretary, accountant, &c.			327 17 6				
Collector's commission			215 5 0				
Stationery and printing			37 11 3				
General establishment charges			66 7 7				
Auditors			15 15 0				
Depreciation-fund (leaseholds)			110 0 0				
Bad debts			121 8 7				
Interests on borrowed capital			391 15 0				
Net profit			4,884 14 1				
			£20,576 18 8				£20,576 18 8

The CHAIRMAN: Gentlemen, in moving the adoption of the report, I may congratulate you upon the satisfactory working of the company for the last six months. It is something like fifteen months since we reduced the price of gas, and, while the quality and purity have been maintained, your revenue has not been depreciated. Although your accounts do not show the usual dividend of 10 per cent., yet it would have been larger if it had not been for that unfortunate accident at Wapping Wall. Your works down at the lower district have been undergoing a course of reconstruction, and there has been a large outlay in these matters, which had become necessary to enable the company to carry on their business with advantage. It is due to the exertions of your engineers that, instead of the former leakage, we have now something like 12 per cent. I shall not detain you any longer with my remarks, and I shall be very happy to answer any question that may be put to me.

A PROPRIETOR inquired what was the nature of the accident referred to.

The CHAIRMAN: Last year Mr. Oliver, of Wapping, was running at the time to catch the train at the East London Railway station, tripped on some stones, and fell into a hole, cutting his face severely. The accident was of such a serious nature that, on the report of the medical gentleman sent to examine him, it was thought best to settle the matter. It is an unfortunate thing, but public companies are always liable to it. The compensation was £550, or, with the total expenses, £617. It was an unfortunate thing, but we did the very best we could to settle the matter. I now move that the report and accounts be received and adopted.

Mr. H. BADDELEY seconded the motion, which was put—carried unanimously.

The CHAIRMAN then moved—"That a dividend for the half year ended June 30, 1871, upon the paid-up capital of the company, after the rate of 5 per cent., less income-tax, be now declared, payable on and after the 4th of October next."

Mr. BROMLEY seconded the motion, which was put and carried.

Mr. NUTTER moved a vote of thanks to the chairman and directors for their services during the past half year.

Mr. WILKINSON seconded the motion, and it was put and carried.

The CHAIRMAN, in returning thanks, said it was always pleasing to the directors to meet the shareholders; and, although there were only a small number of shareholders present, yet the directors would always endeavour to do their best for them all, whether present or absent.

On the motion of Mr. NUTTER, seconded by Mr. SANDER, a vote of thanks was given to the secretary for the efficient manner in which his duties had been discharged during the past half year.

The SECRETARY acknowledged the vote in suitable terms.

Mr. HAMMACK proposed, and Mr. WILKINSON seconded, a vote of thanks to the engineers of the company, which was unanimously carried, and responded to by Mr. H. JONES.

On the motion of Mr. H. BADDELEY, seconded by Mr. WILKINSON, a vote of thanks was presented to the auditors, which was briefly acknowledged by Mr. SANDER, and the proceedings terminated.

BRIGHTON GASLIGHT AND COKE COMPANY.

The Half-Yearly Ordinary General Meeting of the Proprietors of this Company was held on Thursday, the 24th ult., at the Offices, 13, St. Swithin's Lane, London—HENRY WHEELER, Esq., in the chair.

The following report and accounts for the half year ending the 24th of June, 1871, were submitted to the shareholders:—

Influences similar to those in operation prior to the close of last year have served to increase considerably the demand for gas during the past six months. The directors, however, do not find that the larger quantity of coal used has brought a corresponding amount of money return for the coke produced; a circumstance due probably in some measure to the reduction in the price of inland house coal. The lull in the trade of brick-making has also seriously affected the value of breeze.

A trial of some months duration has afforded satisfactory experience of the good construction and working qualities of the new gasholder. This supplies the company with a most valuable reserve of gas storeage, and, when future extention of business shall make such a step advisable, can, at a moderate outlay, be nearly doubled in capacity by telescoping. For such addition, suitable provision has been made, thus effecting a great ultimate economy of space and cost.

The directors recommend the declaration of a dividend on the paid-up capital of the company of 5 per cent. for the half year ending the 24th of June last (less income-tax), the same to be payable on and after the 4th of September next.

Dr. *Profit and Loss Account for the Half Year ending June 24, 1871.* *Cr.*

To Coals	£8,173	16	8	By Gas and meter rental	£13,932	11	2
Materials for purification	283	17	0	Coke, &c.	3,097	5	0
Wages	1,567	6	5	Interest account	42	4	1
Rents, rates, and taxes	284	18	4				
Salaries, collectors commission, directors, and auditors	1,294	4	7				
General charges	170	13	6				
Wear and tear	908	3	4				
Bad and doubtful debts and allowances	120	12	5				
Interest on debentures	300	0	0				
Depreciation account	100	0	0				
Balance	3,868	8	0				
	£17,072	0	3		£17,072	0	3

Dr. *Balance-Sheet, June 24, 1871* *Cr.*

To Capital	£78,300	0	0	By Expended on works	£82,842	18	2
Debentures	12,000	0	0	Meters	2,193	19	2
Contingency fund	4,620	12	6	Coal, coke, &c., in stock	4,595	6	2
Depreciation account	2,082	19	11	Mains, service-pipes, and general stores in stock	1,117	11	10
Coal insurance account	989	0	9	Sundry debtors for gas	6,225	8	4
Dividends unpaid	985	12	3	Sundry debtors for coke, &c.	1,646	4	2
Interest on debentures	161	4	2	Cash at bankers and in hand	5,534	19	11
Tradesmen's accounts, &c., owing	947	17	6				
Balance from last half year £260 12 8							
Balance this half year, as above £3,868 8 0	4,129	0	8				
	£104,216	7	9		£104,216	7	9

The report of the directors, together with the accounts as audited, were approved, and a dividend for the half year ending the 24th of June last, of 5 per cent. on the paid-up capital of the company, less income-tax, was declared payable at the offices of the company, on Monday, the 4th of September inst., and three following days. The thanks of the meeting were given to the directors and auditors for their attention to the affairs of the company; and to Mr. Rutter, Mr. Weare, and the other officers of the company, for the ability with which their respective duties had been performed.

ON THE REMOVAL OF IMPURITIES FROM COAL GAS.

By P. INNES, Gas-Works, Forfar.

[Prize Essay read before the Meeting of the North British Association of Gas Managers.]

The restrictions which, to all appearance, have now been permanently imposed upon the metropolitan and some of the provincial gas companies, in reference to illuminating power and amount of impurity in coal gas, have been the means of keeping alive the attention of engineers to the more difficult of these two subjects—viz., purification—with a view to further improvement. In Scotland we can scarcely say that the subject has attracted the same notice, either externally or professionally, as in England, probably on account of the general use of cannel coal, from which the high illuminating power of the gas obtained neutralizes a greater amount of non-illuminating impurity than is contained in the gas of our southern neighbours; while the rapid exhaustion of cannel in carbonizing prevents the production of so much of that almost unabsorbable sulphur impurity which the long exposure of common coal to a strong heat in similar circumstances is certain to effect in a greater degree. For example, the practice of scrubbing gas, now becoming so prevalent in the larger works of England, is as yet confined to only three or four in Scotland; but, wherever this part of the process of purification has been adopted, the results obtained, in removing at least one valuable impurity, ammonia—the removal of which in this manner leads to a consequent increase in the removal of the other impurities with which it is combined—are such that there is every probability of this improvement being adopted in works which can afford and find employment for a steam-engine.

With such a probability before us, and the likelihood of future sanitary legislation, in respect to other parts of the process of purification, becoming wider in its application, the investigation of the subject of the "Removal of Impurities from Coal Gas" is one which cannot be otherwise than conducive to the improvement in many ways of the gas managers of Scotland, and in opening up what to many of us was a region of doubt and obscurity. The subject is both chemical and mechanical; it requires us to rehearse and enlarge our chemical knowledge of coal gas and its impurities, to be thoroughly conversant with their properties, their reaction one upon another, and the agents employed in their removal; and it also demands of us the practical application of this chemical knowledge to apparatus suitable for removing these impurities advantageously and profitably.

These pre-requisites being before us, we confess that we approach this subject with diffidence and hesitation, knowing that it has been ransacked in every corner, chemically and mechanically, by talented professionals in England and elsewhere, and feeling that to go over the ground which others have trod so well before us, and which the limited size of works in Scotland generally deprives us of that mechanical experience so necessary to add one stone to the cairn of improvement, savours so much of pedantry, and must always be thankless work; still, for the anticipation of intellectual profit and increased professional knowledge which the mere exercise of investigating the subject must entail, we submit to the "*odium gazologicum*" which some parts of this paper will likely incur.

We shall speak, first, of impuritites, their formation, with notices of some of their most important properties in relation to their absorption; and, second, the methods adopted for their removal.

Impurities, their Formation, &c.—The constitution of coal is twofold—vegetable or organic, and earthy or mineral. The organic portion consists of the elementary bodies—carbon, hydrogen, oxygen, and nitrogen, in variable proportions. As one plant differs from another in its chemical composition only in the amount of each of the above constituents it contains, and as each plant likewise is as variable in the amount of silicious or other earthy matter it mechanically holds, we can easily conceive how coal—which is merely vegetable matter impregnated with muddy filterings, and compressed by the weight of the strata successively deposited over it, and, probably, by the internal heat undergoing a slow combustion or bitumenization—should be so complicated in its constitution, and that we should be so totally ignorant of the forms in which its components now exist. The earthy matter contains only one ingredient with which we are at present concerned—namely, sulphur found in combination with iron, as iron pyrites or bisulphide of iron. Later investigations into the nature of coal have led to the belief that sulphur exists to a very small extent in other forms, such as sulphate of lime. It is conjectured also that the organic part contains minute portions in chemical combination with some of the other elements, and it is probable that the existence in coal gas of what are termed sulpho-hydrocarbons may partly arise from this circumstance, as much as from other explanations of their formation.

The carbon and hydrogen may be termed the illuminating elements, and the oxygen, nitrogen, and sulphur the impurity elements of the coal. The effect of such a heat as we employ in carbonizing upon such a compound, containing so many of the non-metallic and volatile elements, is to split it up into a great number of gases and vapours containing two or more of the component elements, leaving as a residue a portion of the carbon containing the earthy matter with about one-half of its sulphur volatilized. First and foremost we have carbon and hydrogen as the hydrocarbons, constituting the bulk of the distillation; but each of these elements is also eliminated with one or other of the impurity elements. Thus we have carbon with oxygen to a large extent as carbonic acid, with nitrogen as cyanogen, and in certain conditions with sulphur as the bisulphide of carbon. Similarly, hydrogen with oxygen is evolved in the form of steam or water vapour, with nitrogen as ammonia, and, appropriating the bulk of the volatilized sulphur, produces sulphuretted hydrogen. In addition to these, we have triple compounds formed, as the hydrocarbon acids and alkaloids found in the condensible products of the distillation, the acids being composed of carbon, hydrogen, and oxygen, and the alkaloids of carbon, hydrogen, and nitrogen. In the retort, and after emergence from it of the bodies there produced, decompositions and combinations take place. On its highly heated and carbonaceous surface heavy hydrocarbons are converted into light ones, and light ones resolved into their elements; water is decomposed into carbonic acid and carbonic oxide, and the first of these otherwise produced split into the latter, depositing carbon. Ammonia is converted into cyanide of ammonium, liberating hydrogen; and there, also, in the same manner, may sulphuretted hydrogen produce the bisulphide of carbon. While the outer surface of the stream of gases and vapours is favourable to a disruption of their constitution, by contact with the hot inside of the retort, that of the interior is as favourable to combination, by reason of its comparatively low temperature. The carbonic acid, with the assistance of the water vapour—without which it has no combinative effect—takes ammonia, forming carbonate of that substance in the form of vapour. Between the mutual reactions of sulphuretted hydrogen, cyanogen, and ammonia, vapours of the sulphide and sulphocyanide of the latter substance are produced. Combination is further facilitated by the passage of the gases through the hydraulic seal, and a considerable portion of the carbonate and sulphocyanide are retained in that vessel; but not so with the sulphide or free sulphuretted hydrogen—at least, above 95° Fahr.—owing to the greater volatility of these compounds. The water in the hydraulic main—which we find in our experience never exceeding 120° Fahr., being very much below the boiling point—will consequently condense and retain all the water of distillation, with the exception of what little the gases at that and a rapidly reducing temperature can sustain.

We may tabulate the principal impurities of crude coal gas as under:—

Alkaline or Basic Bodies.—viz., ammonia and cyanogen, which are more or less absorbed by the

Acids—viz., sulphuretted hydrogen, or hydrosulphuric acid.

Carbonic dioxide, which, when impregnated with water, becomes carbonic acid.

Carbonic disulphide, or bisulphide of carbon, or sulphocarbonic acid, considered in relation to its salts.

These acting on the alkaline impurities produce vapours of the

Salts.—As the sulphide, carbonate, and sulphocyanide of ammonium, which escape condensation or absorption before reaching the purifiers.

In addition to the above impurities, we have often traces of chloride of ammonium, aqueous vapour, oxygen and nitrogen, arising from decomposition or from the admission of air into the apparatus, tarry matter and naphthaline, considered as impurities because the first acts as a carrier of ammonia into the mains, and the latter—deposited from gas and condensible products deficient in illuminating vapour, and those light oils by which it is so readily absorbed—because it chokes up the distributing apparatus, a circumstance which we may say is unknown in Scotland.

We will endeavour to relate, as fully and yet as briefly as possible, some of the most salient properties of the alkaline and acid impurities, especially of those concerned in their removal.

Ammonia.—This well-known gas, the removal of which from crude gas is at present occupying so much attention, is produced in several ways, such as when its elements meet in the nascent state, from organic matter in the course of putrefaction taking nitrogen from the air, or by heating any organic substance containing its elements, such as coal. It is fully one-half the weight of common air, sp. gr. 0·59, and its pungent odour is well known to most people. A cubic foot of the gas weighs 331 grains calculated from its formulæ. It is slightly combustible, but is not a supporter of combustion. It is extremely volatile, being termed the volatile alkali, a property which it imparts to many of its compounds, and to which may be attributed the difficulty of thoroughly removing it from coal gas without injury to its illuminating constituents. It is remarkably soluble in cold water, for at the freezing point water or ice will take 1149 times its own volume of the gas, while at ordinary temperatures it will take up over 500 volumes; or, one volume of water (say a gallon, equal to 10 lbs.) will absorb about 6 lbs. of pure ammonia—an amount which, in some cases, is equal to that which would be produced by converting all the nitrogen in one ton of coal into ammonia. This extraordinary absorption only holds good with pure ammonia. The absorption of ammonia by water is accompanied with the generation of heat, and considerable expansion. A gallon of water, at ordinary temperatures, fully saturated with the gas, or 500 volumes, expands to the bulk of a gallon and a half, a fact which goes so far to explain certain cases of "boiling over" in tar and ammoniacal liquor distillation.

Pure and dry ammonia will combine with certain acids without oxygen—such as sulphuretted hydrogen, hydrochloric acid, &c., combination being direct and without any substitution. In all other cases water or its vapour is a necessary medium of combination, and in such a manner can only be formed the carbonate, sulphate, and other oxygen salts. The salts of the first-class, and the carbonate of the latter class, have the property of volatilizing in an undecomposed state—that is to say, when heated to the vaporous state, they continue as much in a state of combination as when in the liquid or solid state; so that the carbonate, sulphide, and sulphocyanide of ammonium, which are produced in the retort and hydraulic main, continue in the same condition until they meet the decomposing lime or oxide of iron. All the other salts of ammonia part with their ammonia when heated. The principal salt of ammonia in crude gas is the carbonate, as may be guessed from the quantity of carbonic acid produced in the distillation. It is not so volatile as the sulphide, but more so than the sulphocyanide, which may be very easily shown by heating a little of the liquor, and by the ordinary simple tests it will be found that the sulphide disappears first, the carbonate next, while the sulphocyanide is not all expelled at the boiling point. This accounts for the fact

that no sulphide is found in the liquor of the hydraulic main when tested with a lead salt; and, also, that the aqueous vapour in condensing carries down principally the carbonate and sulphocyanide, the more volatile sulphide passing on to the purifiers, if not otherwise intercepted. The ammoniacal liquor in the tar-well and condenser-chest rarely, if ever, exceeds 5° Twaddle, because, before it reaches that, crystals of the carbonate separate out, and settle down into the tarry matter, which lies at the bottom of these vessels. This separation of the ammonia in the crystalline form is especially shown in the condenser-chest and pipes, and that makes the cleanings of that apparatus so valuable, and at the same time so dangerous in distilling, containing as it does such a quantity of ammonia concentrated in the salts. When the liquor gets stronger than 5° Twaddle, as in distilling or washing, the proportion of sulphide increases, which may be recognized by its strong odour compared with the rather pleasant smell of that got from the hydraulic direct. Those who are in the habit of distilling liquor are aware that it can be got as high as 24° Twaddle or more without any salts crystallizing out. The sulphide of ammonia which is contained in gas liquor is not the ordinary sulphide which the chemist uses in his laboratory as a reagent, and which is colourless, but one or more of the polysulphides of ammonium, and as that which gives the yellow colour to the liquor, and to portions of the lime when fouled. Ammonia is detected in gas by exposing turmeric or reddened litmus paper to a jet of gas, when, if present, the turmeric is turned a reddish brown, while the litmus becomes blue in colour; when these tests fail, it may always be detected by holding a drop of hydrocholoric acid (spirit of salt) before an open jet, when the white fumes of chloride of ammonium or sal ammoniac will immediately be produced.

Sulphuretted Hydrogen.—Known also as hydrosulphuric acid, or, somewhat unscientifically, as the gas of rotten eggs. It is generated from putrefying organic matter containing sulphur, or by heating any of the natural sulphides in the presence of water vapour at a high temperature—the mode of its production in the distillation of coal, where the sulphur liberated in the conversion of the bisulphide of iron into photosulphide takes the hydrogen of the water vapour. It is soluble in water to the extent of about three volumes of the gas in one volume of water, at ordinary temperatures. It imparts its acid reaction to the water it dissolves in, and in this form it is used as a well-known reagent by the chemist. With ammonia it forms several sulphides, rarely, if ever, seen but in solution; the lower of these is colourless, but becomes yellow on keeping, like that in gas liquor, owing to the formation of higher or polysulphides. With one exception, none of these sulphides crystallize at ordinary temperatures, and hence the reason why ammoniacal liquor when distilled, the first runnings, composed chiefly of sulphide, come off at such high specific gravities as 24° or more Twaddle; while that of the tar-well, or condenser-chest, where no scrubbing takes place, being composed principally of carbonate, rarely exceeds 5° Twaddle, owing to the separation out of it in crystals. The process of condensation and absorption of ammonia salts after carbonization is accomplished in the reverse order of that which takes place on the distillation of ammoniacal liquor, from obvious reasons. After carbonization, we have sulphocyanide with carbonate left in the hydraulic; before entering the condensers, principally carbonate, coloured with a little sulphide, which increases as the gases pass through the condensing-pipes, carbonate, meanwhile, as the aqueous vapour diminishes, being deposited on their sides. In the distillation of the liquor, the more volatile and uncrystallizable sulphide is carried over first, on account of the low temperature at first, and the water, from the same reason, is also limited in its production of vapour, so that a large volume of the gaseous sulphide absorbed in a comparatively small amount of water, in the form of vapour, is carried over and condensed, producing a solution of the sulphide of the high specific gravities already mentioned. As the heat increases the water vapour increases, which reduces the strength of the liquor, and the carbonate, increasing as the density diminishes, follows next in abundance. When the liquor is run off to 1° or 2° Twaddle, it consists chiefly of sulphocyanide and carbonate, with little or no sulphide if the heat has been strong.

As the absorption of sulphuretted hydrogen is effected by its forming a sulphide with the absorbent, a word or two about that class of bodies may not be amiss. All the metals will combine with this impurity of coal gas, forming sulphides, and many of the most valuable metallic ores are found in that form. Some of these sulphides are soluble in what are termed acid solutions, some in alkaline solutions, while a third class are soluble in either kind of solution. This behaviour of that class of bodies makes sulphuretted hydrogen one of the most important classifying tests that the chemist has in his laboratory, and enables him to group the metals into three classes, including the alkaline and earthy metals; for, by observing the behaviour of the substance under examination with this gas, or a solution of it, he can at once tell what metals may be, and what certainly are not present. As we fear that to dwell on this subject may be considered foreign to the purpose of the essay, we only say further, that in conducting investigations into any processes for the removal of this impurity by metallic solutions or other absorbents, or in examining the results of the decompositions which then take place, a knowledge of the properties of this gas is absolutely indispensable.

We may gather, however, from what has been said, that it is the easiest absorbed of the impurities, having no lack of absorbents. Those generally used are lime and oxide of iron. Absorption by lime is a process of simple substitution, in which the sulphur of the impurity takes the metallic portion of the lime, forming sulphide of calcium, while the oxygen of the lime and the hydrogen of the impurity form water. The process is similar when the impurity meets the lime as sulphide of ammonium, producing, in addition, aqueous ammonia, impregnating the lime. With oxide of iron the absorption is likewise similar to the lime—which is an oxide of calcium—forming water and protosulphide of iron, but as this reaction is extraordinarily weak with the simple oxide, the hydrated peroxide, or ferric oxide, is used.

The usual tests for sulphuretted hydrogen are acetate of lead, or nitrate of silver, effected by moistening slips of white paper with strong acid solutions of these bodies and exposing them to a current of the gas. The use of a shilling over a pet cock on the purifiers is not quite obsolete.

Carbonic Acid.—The gas having the formula CO_2, and known popularly by this name, is not like sulphuretted hydrogen, an acid in the dry state, but a double oxide of carbon. It is only when it dissolves in water, or meets any other substance in a moist condition, that it possesses acid properties, and forms carbonates. It is produced in many ways, such as by heating any of the carbonates, as in the burning of limestone, during fermentation, and largely by the combustion of carbon, or of any substance containing it, such as wood, tallow, coal, or coal gases, in oxygen, or in the air which is merely a dilution of it. It is likewise produced by the distillation, at high heats, of carbonaceous substances containing oxygen, and such is the method of its production in the manufacture of coal gas.

Carbonic acid is very heavy, so much so that it can be poured from one vessel to another like water; its sp. gr. is 1·52, or one-half heavier than air, or three times the ordinary weight of coal gas, and from this fact it will be seen that the density of coal gas is no criterion of its quality if it contains any of this impurity. It is incombustible and irrespirable, and it is found that illuminating gas, containing 1 per cent. of carbonic acid, loses 5 per cent. of its illuminating power. It combines readily with all alkalies, moistened or in solution, especially with potash, and on that account is that absorbent adopted in endiometrical analyses. Its removal from crude gas is invariably effected by lime, and in the purified gas it is detected by lime water. In solution its presence is likewise shown by effervescence when treated with a strong acid. The compound of it with ammonia we have already mentioned. Like the other impurities which we have spoken of, carbonic acid is soluble in water to the extent of about one volume of the gas in one volume of water, but combined with ammonia that property is greatly increased.

Bisulphide of Carbon.—Carbonic disulphide, or for a similar reason to which carbonic dioxide is called carbonic acid, so this substance is termed sulphocarbonic acid. The vapour of this substance, which is a dense volatile liquid of a peculiarly unpleasant odour, is produced whenever the vapour of sulphur is passed over red-hot carbon or coke, and such is the manner of its production in the retort when carbonizing. When a charge of coal exhausted of its hydrocarbons is allowed to lie in the retort any considerable time afterwards, the coke, which is then in a red-hot condition, will expel a further portion of the sulphur—which the iron in the coal retains in moderate carbonization—in combination with carbon as bisulphide, and thus unnecessarily increasing the amount of this difficulty of absorbed impurity in the purified gas. The quantity of this impurity which is produced during carbonization, we believe is greater than is supposed, especially in earlier parts of the process of distillation; but on account of some reactions it has with ammonia and other decompositions, it is converted into sulphuretted hydrogen and other absorbable impurity, except near the end of the distillation, when no ammonia occurs. As its removal from coal gas is a subject which is constantly exercising the attention of gas engineers, we may bring forward a number of its properties and reactions which modern chemistry has brought to light. The density of the vapour is 2·67, or 2⅔ times the weight of air, or nearly six times the weight of ordinary coal gas. It is soluble in alcohol, ether, and most oils, but is insoluble in water. The vapour is very inflammable, producing, in its combustion, sulphurous and carbonic acids. It is decomposed in several ways, as by passing the vapour over metals and metallic oxides at a red heat, producing a metallic sulphide in addition to the products of combustion. High-pressure steam at a temperature of 300° Fahr. decomposes it, yielding sulphuretted hydrogen and carbonic acid. Passed over red-hot copper, it produces sulphide of copper and marsh gas. We observe that these last two reactions have been taken advantage of in a patent lately taken out, in which it is sought to improve the illuminating properties of coal gas and remove impurity by passing the impure gas "through a coil of metal pipe, by preference of copper, heated to redness, or through other highly-heated passages or chambers, in order to raise the gas to a high temperature before entering the purifiers." Superheated steam is also proposed in the specification to be "combined with the gas as it issues from the retorts into the hydraulic," &c., &c., the object being apparently to decompose the bisulphide of carbon into an absorbable form. The passing of the gas partly cooled through a red-hot copper pipe, although it might produce marsh gas and a metallic sulphide in breaking up the bisulphide, would be more than counterbalanced by the loss in decomposed hydrocarbons. But we have long considered that the use of steam at a high pressure might be adopted to some advantage in the purification and improvement of coal gas in its illuminating properties, not so much in breaking up the bisulphide of carbon, as in replacing the water of distillation in the gas of which it was deprived in passing through the hydraulic, and thus again using an agent eminently fitted, in a form and in quantity, to search out and retain those impurities which have so decided a preference for it. With nascent hydrogen the bisulphide of carbon produces sulphuretted hydrogen and another sulphur compound, a reaction which probably takes place near the end of the distillation. The sulphides of the alkalies combine with this impurity, forming sulphocarbonates, and from this reaction can the real sulphocarbonic acid be formed. It is also by this reaction that washing crude gas with ammoniacal liquor in scrubbers or washers is expected to remove the bisulphide of carbon. Dr. Letheby tells us that this impurity acting on the ammonia in purified gas produces there sulphuretted hydrogen and sulphocyanide of ammonium, and in this way accounts for the cyanogen compounds found in meters and distributing apparatus generally.

There are several tests for bisulphide of carbon, but difficult in their manipulation. They mostly depend on the solubility of the impurity in alcohol or ether, distinguished by their solvent action likewise on phosphorus, iodine, or compounds of these substances, and the colours produced on the solution and on the yellow precipitate it gives when a solution of it in alcohol and potash is treated with a copper salt, &c., &c.

The Methods adopted for the Removal of the Impurities.—In considering the removal of the impurities, we shall confine our remarks mainly to ammonia, sulphuretted hydrogen, and carbonic acid. For obvious reasons, ammonia is always sought to be removed before entering the purifiers. The amount of this impurity in the crude gas, when it gets that length, appears to be variable, and must be so, according as condensation is effective or not. Dr. Letheby informs us that not more than 1 volume of the impurity in 1000 volumes of the gas should enter the purifiers; while a French professional tells us that from 2½ to 5 grammes in the cubic mètre in summer is the proportion. This last quantity is equal to from 3 to 6 volumes in the 1000. One cubic foot of ammonia, as we have learned, weighs 331 grains, and allowing 10,000 cubic feet of gas per ton of coal, and also aware that to convert the ammonia into sulphate requires three times its weight of strong sulphuric acid, the simple calculation,

$$\frac{3310 \times (3310)\ 3}{7000}\ \text{grs.} = 1{\cdot}9\ \text{lbs.},$$

tells us that ammonia has been lost in the purifiers sufficient to produce nearly 2 lbs. of sulphate per ton of coal, when 1 volume per 1000 has entered the purifiers, and 12 lbs. per ton by the Frenchman's highest estimate; a very nitrogenous class of coals these last must certainly be. There can be no doubt, however, that in small works with defective condensing and absorbing apparatus the loss of ammonia is considerable. As neither lime nor oxide of iron have any chemically-absorptive influence over ammonia, it is clear that, with the exception of what is mechanically suspended by these agents in the purifiers, this impurity, to a considerable extent, will pass into the gasholders and mains. Let us try to follow the course of ammonia through lime, where this alone is used for purification. When it meets the lime it may be in the free state, or as the various salts of it held in suspension by the water vapour. When these salts touch the lime, whether on the surface or swept within, they are decomposed, forming similar or compound salts of lime, liberating the ammonia. The reaction generates heat, and produces water in the form of vapour, in which, and that with which the lime was slaked, the liberated ammonia is absorbed. As there is always an abundance of free carbonic acid and sulphuretted hydrogen, portion of the liberated ammonia is again taken up by these acids, forming vaporous salts again, which, with the other gases, are carried deeper into the lime and subjected to another decomposition similar to the first. This reaction goes on as the lime gets fouled, only that the amount of free ammonia increases on the passage through the lime, while that of the salt vapours diminishes. When the surface of the lime gets fouled, and, as usual, tarry matter collects there, the ammonia impurities swept on to it adhere and accumulate there to some extent. On opening a purifier which has been fouled, for recharging with lime, and in which the impure gas goes down through the lime—as in our own—the pungent odour tells us at once that ammonia is detained by the lime, and that the amount is greatest on the surface may be ascertained by quickly slicing off the upper part of it, when the ammoniacal odour is greatly lessened. Passing downwards to the second tray of lime, we find the smell of ammonia from its surface very faint, that of sulphuretted hydrogen predominating, and so on through the extent of purifying material. The water vapour produced by the chemical action of the impurities on the lime, and that also from the slaking of the lime, is absorbed by the gases and impurites heated on their passage through it, and being quickly reduced in temperature on entering the connexions underneath the purifiers, is there condensed, charged with impurities similar to what occurs in the condensers. This water varies in strength from 1° to 8° Twaddle, and also in the amount of each impurity it contains according to the condition of

the lime at the time it is drawn off, and is an instance on the small scale of the efficacy of water in the vaporous condition for absorbing impurity.

While much of the ammonia is thus mechanically withdrawn from the gas, there is still more than is desirable, especially in this utilitarian age, escapes absorption, and passes on with the otherwise purified gas. To absorb this, with other impurity, before it enters the purifiers, in a manner suitable for utilization, the history of coal gas manufacture abounds in numerous methods proposed or adopted for effecting this purpose. These may be divided into four classes, in most of which more or less of sulphuretted hydrogen and carbonic acid are simultaneously absorbed.

1. The simple absorption of ammonia by water.
2. The absorption of ammonia with other impurity by increasing the amount of alkaline impurity, as in the process of washing or scrubbing with ammoniacal liquor or with aqueous ammonia.
3. The absorption of ammonia by a dilute acid.
4. The absorption of ammonia and sulphuretted hydrogen together by a metallic or alkaline salt, in the dry state or in solution.

The first of these methods is based upon the solubility of ammonia in water, and is effected in washers and scrubbers. In the former of these apparatus, now little used, the gas was passed in sheets, or large bubbles, underneath a broad surface of water, which, acting on the outside of these bubbles, led to a condensation and absorption of impurity and tarry matter. This first application of the principle of absorption by water was a rude one; the sudden contact of the gas with the cold water in such masses, more especially in winter time, must have been the means of liquefying much of the illuminating vapour by the rapid reduction of temperature. It was imperfect in its action likewise, as the interior of the gaseous bubbles was unacted upon, and so the greater part of the gases escaped the absorbing influence desired. In addition to this, the pressure it reflected on the retorts in small works, where no exhauster was used, was a decided objection to it. The next improvement in its application was in employing it in coke, or other kind of scrubbers, in the form of a shower, the water being introduced at the top, and, by means of distributing apparatus, met the ascending gas in a more searching manner than in the washer. A still better and more natural form of application is what is called the Goldsworthy Gurney jet, which, by driving the water into a fine spray, gives it a still greater intimacy with the impurities for absorption. In the washer, the liquor obtained would be somewhat in strength similar to that in the condenser-chest or tar-well; but, in the case of the scrubber and spray jet, on account of pure water in great volume being at first employed, the resulting liquor would be of little value owing to its weakness. Had the scrubbers or spray jet been employed before the gas entered the condensers, and the warm gas treated with spray in the form of steam, a different result would undoubtedly have occurred. A desire to have gas liquor in a more concentrated form for carriage, the knowledge of the fact that alkaline sulphides can decompose bisulphide of carbon, and that washing with gas liquor already saturated with hydrocarbons will accomplish these ends, bring us to the second class of processes, which have for their object—

The absorption of ammonia, with other impurity, by increasing the amount of alkaline impurity in the gas.

Assuming that crude gas, when it gets the length of the purifiers, contains only 1 volume of ammonia, 8 of sulphuretted hydrogen, and 20 of carbonic in 1000 volumes of the gas, as Dr. Letheby says that it ought not to exceed that amount, this gives us 28 volumes of acid to 1 of alkaline impurity; and, supposing that the alkaline impurity is totally absorbed—which never happens in any process—it still leaves over 27 parts of acid to be removed by the purifiers. It will thus be seen that the removal of acid impurity is prevented by the absence of sufficient alkali to neutralize it, and, we may add, of water to retain it; for, to carry any more alkali than what at present exists in gas to the purifiers, would just lead to a greater amount of it in purified gas. Washing the crude gas with gas liquor until it attains a certain strength, and introducing into the gas pure ammonia in solution, are means which are employed for removing part of this excess of acid, and at the same time to pick up ammonia also. The theory upon which this is based is self-evident when pure ammonia is used; but we are afraid that there is an error in supposing that common gas liquor can remove acid impurity by imparting to it ammonia for absorption. Ammoniacal liquor, as we get it, contains no free ammonia, as it all exists as sulphide, or carbonate principally, and, if there is any free impurity in it, it is acid, sulphuretted hydrogen or carbonic acid; its smell tells that plainly, and in general it is the former of these acids.

To introduce ammonia in the form of carbonate and sulphide, as in gas liquor, is useless in endeavouring to lessen the acids by chemical absorption, and as far as mechanical absorption is concerned, ordinary water is more potent in this respect, used in the same manner as the liquor, pumped over and over again until it reaches the desired strength. By repeated washings with gas liquor we may absorb acids by virtue of their solubility in water, and we may search out some more of the salt vapours of ammonia by the same means; but this is mechanical absorption, not chemical, and the strong liquor thus obtained will contain excess of acid generally, sulphuretted hydrogen being more soluble than carbonic acid. Pure caustic ammonia introduced into crude gas in a gaseous or finely divided aqueous state ought to be most effective in removing sulphuretted hydrogen and carbonic acid, as theoretically two volumes of the alkali will absorb one volume of sulphuretted hydrogen or carbonic acid in producing the vapour salts of these acids, so that 54 volumes should remove all the forementioned amount of acid impurity, or 560 cubic feet of pure ammonia gas ought to remove all the impurity of a ton of coal which reaches the purifiers without lime or oxide. The practical working out of this idea has not been very successful, we believe, and we attribute it as much as anything else to the process by which the ammonia, or what goes under the name, is made. In most of these it is by heating gas liquor with the intention of driving off sulphuretted hydrogen and carbonic acid, and leave ammonia. We maintain that pure ammonia, or a liquor containing any amount of free ammonia worth consideration, can never be made in this way. We mentioned before, when speaking of ammonia, that the salts of those acids contained in crude gas all volatilize in an undecomposed state; hence, when gas liquor is heated, the excess of sulphuretted hydrogen is first driven off, and what in the liquor is combined with ammonia in being expelled by the heat carries its ammonia with it, and the same applies to carbonic acid. So that in attempting to purify gas liquor by heat, we only lose ammonia with the acids driven off. The same objection holds in trying to purify gas liquor by filtering through lime. The only way is to distil the vapours through lime in the same manner as in the manufacture of caustic ammonia. Again, we think the manner of producing or effecting the absorption of acid impurity by a solution of pure ammonia distributed in the form of a shower gives insufficient intimacy of alkali with acid to obtain the desired effect in the best manner, and we may be excused if again we bring forward steam in which ammonia (caustic) is volatilized, as a medium calculated to permeate the gas in a manner most suitable for the extraction of sulphuretted hydrogen and carbonic acid, where such is desired to avoid or diminish the nuisance of spent lime or foul oxide. It may be objected to the use of steam in this form, that strong alkali is hurtful to hydrocarbons in the same way as strong acids are, and that the bisulphide of carbon would lose the decomposing influence of the sulphide of ammonium in the scrubbing process. To the first objection it may be said that the alkali, we presume, can be volatilized to any degree of strength, and that strong ammoniacal liquor is hurtful to the illuminating vapours of coal gas as well as puro alkali; to the latter, a comparison of testings for sulphur in the gas of companies who wash and scrub their gas and of those who do not, leads us to believe that very little of that reaction takes place in the process of scrubbing, at least in the case of cannel gas. The quantity of the bisulphide of carbon in gas is so small—supposing the 20 grains in the 100 cubic feet were wholly composed of that substance, it would only be equal to one-sixtieth ($\frac{1}{60}$) part of a cubic foot of the vapour—that we do not wonder it escapes absorption by the imperfect contact of the liquor with the gas when presented to the gas in a shower. In the analysis of the gas of one company, where purification is conducted only by condensation and lime, we find the same amount of sulphur impurity as in the gas of a work in the same city where washing or scrubbing is effected, and this is generally constant.

Of the mechanical arrangements for regulating the supply of liquor in scrubbing gas, our space will not allow us to say anything further than that their construction should be so as to deliver it in a manner as near as possible to that exhibited in the natural process of condensation. There we have not a great body of water operating. Quite the reverse. When we consider the low temperature at which the water in the hydraulic is, rarely exceeding 120° Fahr., and that, as already mentioned, all the water produced in the distillation of the coal is there condensed, with the exception of what little the gas can retain at that temperature, and further, that this water is usually separated from the gas at the end of the hydraulic, it will be seen that the actual amount of water which proceeds with the gas is extremely small, but it has this advantage, that, being in the form of steam or vapour, the gas is completely intersected with it, and consequently the water gets impregnated with impurity to a greater extent than any artificial process as yet has effected. What we need is a *series* of natural condensations produced by an intermittent supply of water in a state of fine vapour.

The third method of absorbing ammonia consists in passing the crude gas through a very dilute solution of an acid, such as sulphuric acid, or between the interstices of seme porous material, such as sawdust, saturated with the dilute acid. The gas passing through the solution leaves the ammonia in it, becoming an impure solution of sulphate of ammonia, the supply of acid being regulated so as to cause the acid to reach a certain specific gravity or saturation before removal for utilization. When passed through acidulated sawdust—the more practicable of the two methods—the sulphate is washed out and utilized as formerly. Objections have been raised to this method of removing ammonia, first, because it is corrosive in its action on the apparatus, an objection which can scarcely be applied to such diluted solutions as are actually necessary for absorption; and, second, that fumes of the acid are likely to get into the purified gas and exert their influence on the fittings of meters, &c., an objection which has less foundation than the first, when it is considered that the gas has subsequently to pass through lime with which it would form sulphate of lime, one of the many absorbents which have been used in connexion with the fourth method of removing ammonia—viz., by means of a metallic salt in solution, or in the dry state, sulphuretted hydrogen being absorbed simultaneously. This class of absorbents are numerous; indeed, almost any salt not containing the acid impurities may be used in the removal of ammonia with sulphuretted hydrogen. We can here only enumerate some of those which have been tried—viz., sulphate of lime, formed by sprinkling the first tray of lime with dilute sulphuric acid or the same agent as gypsum. Sulphate of iron or ferrous sulphate, formed by treating oxide of iron with sulphuric acid, or the same substance in a crude state termed copperas, and a mixture of the sulphates of iron and lime (Laming's mixture), chloride of lime (calcium), solutions of the chlorides of manganese, and sulphates of lead and manganese, &c., &c.

Some of these agents we believe are still used in the larger gas-works of England and the Continent; none in Scotland. The absorption is by what is termed a double decomposition in most cases, the ammonia taking the acid of the salt agent, forming a corresponding salt of ammonia, while the sulphuretted hydrogen takes the metallic part of it, forming sulphides of the metals. With the lime salts, such as the sulphates of lime and the chloride of lime, the whole three impurities may be partly absorbed.

Having, with one or other of these methods, left the minimum of ammonia in the crude gas, and at the same time absorbed sulphur, we have briefly to considered the removal of sulphuretted hydrogen and carbonic acid in the purifiers. In the smaller gas-works these are removed simultaneously by hydrated lime. In the larger works it is becoming the practice to remove the sulphur first by oxide of iron, and the carbonic acid subsequently by lime. Oxide of iron, or, properly speaking, the hydrated peroxide of iron, may be prepared artificially, but in many cases it is used for purification in its natural state, mixed up with some granular substance, such as sawdust, to give it porosity. In most of the rocks composing the crust of the earth this substance is met with in all proportions, from the old red sandstone from which it derives its characteristic colour, containing 6 to 7 per cent., to the rich hematitic iron ores of the north of England, containing 95 per cent. of the peroxide. As we generally observe it in gas-works it has a brown clayey appearance, containing a medium porportion of peroxide. It is likewise obtained in a fine powder, and in this form it is suitable for mixing with sawdust. It is also to be had mixed with sawdust ready for use. Like lime, for the purpose of facilitating chemical action, it is moistened with water.

The mixing of oxide of iron with sawdust for the purpose of giving porosity reduces the amount of purifying material bulk for bulk, compared with lime, so much, that purifiers for using oxide require to have a greater area than lime purifiers, and if a natural ore is employed, having a small per centage of peroxide, the purifying ability of any given area will be considerably lessened from what it would be with an ore with a medium per centage, or the ore will require to be thicker in the trays the less peroxide it contains. Little or no smell arises from spent oxide until it is spread out for the purpose of revivification. This process is effected by the iron taking oxygen from the air and again becoming oxide, while the sulphur is set free. Of course all the sulphur is not liberated, as the air does not get into contact with the sulphide completely, lying as it does in mass; but the greater the space it covers the more of it will be converted again into oxide, and suitable for absorption of more sulphur.

The sulphur now extracted, we have still 20 parts per 1000 of carbonic acid to remove, or about three-fourths of all the impurity which reached the purifiers; and, speaking roughly, three-fourths of the lime used, when it is employed to remove both sulphuretted hydrogen and carbonic acid, will still be required to extract the latter impurity. This is more satisfactorily done when the impurities are removed *seriatim* than when lime alone is used for removal of all the impurities, for although the other impurities are small in quantity compared with carbonic acid, yet the manner in which the lime gets clogged up with ammonia and tarry matter results in the loss of a portion rendered unfit for purification.

The extraction of carbonic acid alone is attended with no smell, the carbonate produced being inodorous, and to those accustomed to the by no means mellifluous fumes of the foul lime of a small gas-work, it is refreshing to stand over a foul carbonic acid purifier when opened for removal of lime. Not only has it no smell, but, as we have seen, it is colourless, something like clalk when compared with the browner clean lime close by.

Where no sanitary restrictions are laid upon a gas company, lime is the best absorbent of acid impurity that can be employed. From its half-alkaline, half-earthy nature it has no chemical action upon the illuminating vapours and gases. Compared with oxide of iron, it will remove sulphuretted hydrogen and carbonic acid in less area than the oxide will remove the former of these alone, and for these and some other reasons we should prefer the use of lime alone, even in pretty large works.

But to obtain purification by lime in the most economical manner certain

conditions must be fulfilled, a few of which we may notice. The crude gas ought to be well stripped of its tarry matter before entering the lime, either by washing or by good condensation, which may be furthered by having the purifiers a distance from the condensing apparatus, or by giving the gas a circuitous route to them. When the tarry matter collects on the outer surface of the lime, it cakes or hardens, the pressure on the retorts increases, and if the purifier is not opened and the lime broken up or renewed, the lute water will soon be blown out of the purifier with escape of gas, by the resistance of the lime, and of the gas being unable to penetrate it. This is a matter of constant experience, especially in winter time, with imperfect condensing apparatus, and requires watchfulness on the part of the men in attendance. During the time of greatest manufacture, it is a practice when one purifier has been renewed that the other be opened and the hardened lime broken up, which is easily effected when the gas passes down through the lime—the better mode in small works for this very reason—but when the reverse is the case, with other annoyances, it leads to a loss of lime in partly replacing foul lime with fresh, although not indicating foul gas on testing.

The lime ought to be in a granular or mealy state; if it be too fine it will cake with its own weight and the water with which it is saturated, and become impervious to the gas, and seek a passage elsewhere. If, on the other hand, the lime be lumpy, it results in a loss of it from the same reason; because the impurities cannot penetrate beyond the surface, and, consequently, the solid interior does no work. A ton of lime working under either of these extremes will, of course, purify less gas than in the medium state, and it shows the necessity of having a person specially set apart and instructed for the purifying department even in the lesser works. The lime ought to be well moistened, and that operation only done shortly before required, or at the time of renewing that in the purifier. Limestone is a carbonate of lime. When burned in kilns the carbonic acid is driven off, leaving it in the form of oxide of calcium, or quick or caustic lime, and in this state we get it from the lime-burner. Exposed to the air, it absorbs moisture from it, becoming hydrate of lime. In practice the same thing is effected by pouring water over it. The chemical absorption of the water by the lime in producing hydrate generates considerable heat, and causes it to crumble into pieces, occupying about twice its former bulk. In this state, termed hot lime, it is unfit for purifying gas. It requires to be further saturated with water, when it will greedily absorb carbonic acid. Lime water, which is a solution of the hydrate in water, soon becomes useless as a reagent to the chemist if left exposed to the air, owing to its absorption of carbonic acid. The dry hydrate does the same, but when further moistened it very soon becomes coated with carbonate of lime from the same cause, and hence the importance of not saturating the hot lime any considerable length of time before being required, or otherwise a quantity of useless lime, coated with the very impurity we wish to take from the gas, will be put into the purifiers to no purpose. When this does take place it may be mitigated by beating and breaking up the lumps, and repeatedly turning it over and over in order to expose fresh surfaces to the crude gas. It is a very good plan practised in some works to moisten the hot lime moderately, which preserves it in a granular condition better, and, when placed in the purifier, to give it a good drenching from a watering-can, the lime being placed in in a thin layer first, then watered, another layer of lime, and another watering until the desired thickness of lime is attained; but the time occupied in this would require a purifier always out of action. It is also a good plan not to slake the shells themselves too early.

Time is an important element in purification. In order to effect chemical action completely, or what comes to the same thing, the area of purifying material necessarily depends upon the volume of gas passing through it. A certain volume of gas, slowly permeating any given depth and area of lime or other purifying agent, will be deprived of its impurity at less expense of it than when double the volume of gas is passing through the same area and depth of material. A case is before us. The same amount of lime which in winter purified on an average 80,000 cubic feet in one day, is at the present purifying over 120,000 cubic feet in seven days. In the former case the gas passed through the lime at the average of nearly 2000 cubic feet per hour, the purification being effected in winter in two sets of purifiers, while at present it is only at the rate of about 800 cubic feet per hour; so that to obtain the same work from the lime in winter as at present, the purifiers would require to have their area more than doubled with the same amount of lime spread over the increased area. In the latter case the gas or its impurities have time to linger over and search through the lime, causing a greater absorption by it; in the former, while part would be absorbed in the first tray, other portions would be swept right through altogether on to the second, which would be purifying simultaneously with the first, and the same incomplete action of each tray of lime carried forward to the last tray as a consequence resulted in the indication of foul gas earlier than is at present. Where plenty of purifying area is to be had, the lime ought to be thinly spread on the trays, and a sufficient space should intervene between the lime and the upper tray in order to (if we may use the expression) allow the gas to readjust itself before entering the lime again. When the lime is thickly spread on, as in some cases it is compulsory to do so where defective purifying apparatus occurs, the interior of the lime becomes a perfect hotbed by the heat which is generated in the combination of the impurities with the lime. The water it was saturated with is converted into vapour, which the rapidly passing gas carries with it, and thus the lime loses its absorbent power, for without water it is almost useless. The heat generated in the interior of lime in such cases is considerable, and from repeated trials we have found it reach to 100° Fahr.—a temperature which is almost that of the gases on leaving the hydraulic. Indeed, we have found such as low as 95° Fahr., being less than that of the lime in the purifiers.

It does not take place so much in lime thinly spread, owing to the heat being better diffused in the space above and below, and for other reasons. Better, if possible, to have a greater number of trays of lime thinly spread than a few with the same, 5 or 6 or more inches deep. When no suitable intervening space is left between the lime and the upper trays, the gas is apt to proceed in straight lines from the perforations in the trays, thus forming holes in which the lime being soon fouled, the gas which follows will derive no absorption of impurity, the object being to get the gas to disseminate itself in all directions through the lime, which it cannot do if not allowed some freedom on emerging from each tray of lime.

Except in the smallest works, not less than three purifiers should be in one set, and renewed with lime when the second is fouled. This is far from being the case, however, many not having more than two in the set, the consequence of which is that while the one is being recharged with lime, the other is passing foul gas into the holder, unless the change should be made when the first purifier is fouled; but as in that case the lime is far from being thoroughly utilized, it would lead to a great expenditure of lime, which small gas companies cannot afford, or are unwilling to incur the expense of.

The condensation of the water vapour which collects in the connexions underneath the purifiers ought to be regularly drained off, and more so in winter, as it is saturated with sulphuretted hydrogen, and the purified gas is apt to absorb some of its vapour emanating from the water.

Death of the Chairman of the Western Gas Company.—The death is announced of Mr. Francis William Russell, M.P. for Limerick, which occurred suddenly on Wednesday, Aug. 30, at his London residence, 27, Lancaster Gate, from heart disease. He was the eldest son of the late Mr. John N. Russell, a merchant of Limerick, and was born in the city of Limerick in the year 1800. He received his education at Farmoy, under the Rev. T. D. Hincks, and subsequently at Belfast, and at Trinity College, Dublin; and he was called to the Irish Bar in 1824. He subsequently became a partner in the firm of Messrs. J. N. Russell and Sons, merchants, in Limerick and London. He was chosen as one of the members for the city of Limerick at the general election in July, 1852, and had held his seat since that period. He was for some time chairman of the National Discount, London Bank of Mexico, and the Western Gas Companies, and was well known and highly respected in City circles. The deceased gentleman had been suffering from ill-health for some time past, but his sudden decease was unexpected by his friends.

Average Composition and Quality of the Metropolitan Waters, in August, 1871.—The following are the returns of the Metropolitan Association of Medical Officers of Health:—

Names of Water Companies.	Total Solid Matter per Gallon.	Oxygen required by Organic Matter, &c.	Nitrogen.		Hardness.	
			As Nitrates, &c.	As Ammonia.	Before Boiling.	After Boiling.
Thames Water Companies.	Grs.	Grs.	Grs.	Grs.	Degs.	Degs.
Grand Junction	18·47	0·109	0·125	0·002	14·0	3·5
West Middlesex	17·79	0·044	0·091	0·001	13·9	3·3
Southwark and Vauxhall	18·03	0·096	0·091	0·002	13·8	3·3
Chelsea	18·23	0·121	0·142	0·002	14·0	3·3
Lambeth	18·27	0·091	0·125	0·001	14·0	3·3
Other Companies.						
Kent	27·93	0·004	0·218	0·000	20·0	5·6
New River	16·83	0·030	0·110	0·000	13·4	3·0
East London	17·93	0·057	0·156	0·000	13·8	3·0

Note.—The amount of oxygen required to oxidize the organic matter, nitrites, &c., is determined by a standard solution of permanganate of potash acting for three hours; and in the case of the metropolitan waters the quantity of organic matter is about eight times the amount of oxygen required by it.

The water was found to be clear and nearly colourless in all cases but the following, when it was slightly turbid—namely, in the case of the water of the Chelsea and the Grand Junction Companies. The average quantity of water supplied daily to the metropolis during the preceding month was, according to the returns of the water companies to the Association of Medical Officers of Health, 112,107,697 gallons; and the number of houses supplied was 489,351. This is at the rate of 34·4 gallons per head of the population daily.

Hy. Letheby, M.B.

Pollution of the River Darwen.—A short time ago an action to recover £25,000, from the Corporation of Blackburn was brought by Sir William Henry Fielden, Bart., as compensation for damage done to his residence, Feniscowles Hall, and the surrounding estate, by the pollution of the river Darwen through the Corporation of Blackburn turning the sewage of the town into the Blakewater, a tributary of the Darwen. The matter was referred to the arbitration of Mr. Manisty, Q.C., who assessed the damages at £1250, and ordered the corporation to pay costs. Sir William is now about to seek further compensation, this time from the Over Darwen Local Board.

The Sewage of Cambridge.—We are glad to be able to report that the local authorities at length appear to be aroused to the importance of attending to the purification of the Cam and the diversion of the sewage of the town from that stream. We are informed that the town surveyor has recently received instructions from the joint committee appointed on the subject to communicate at once with one of the highest authorities in these matters, Mr. J. Bailey Denton, of Whitehall Place, London. The above committee, it may be remembered, is composed of the Parliamentary Committee of the Improvement Board, a syndicate representing the University, and several members of the Town Council, with Mr. Alderman Balls as chairman. In accordance with the above instructions, Mr. Denton has been down to Cambridge, and visited various sites suitable for the purposes of sewage irrigation, and it is expected that at the next meeting of the Board of Commissioners in October certain schemes will be submitted for their consideration. The hope will be generally joined in that no time should be lost in carrying into effect some efficient plan for disposing of that which has been to Cambridge a constant source of annoyance on the one hand, and of danger of disease (to say the least) on the other hand. It is expected that the present system of sewerage will be utilized in either scheme now under consideration, which, if practicable, will save a large sum of money in the execution of the requisite works.—*Cambridge Chronicle.*

Register of New Patents.

APPLICATIONS FOR LETTERS PATENT.

2233.—Francis Parry, of Piccadilly, in the co. of Middlesex, gentleman, for "*Improvements in apparatus for drying precipitated sewage and other like substances.*" Aug. 25, 1871.

2243.—Henry Young Darracott Scott, of Ealing, in the co. of Middlesex, major-general, C.B., for "*Improvements in the treatment of sewage.*" Aug. 26, 1871.

2245.—James Amos, of Ashford, in the co. of Kent, miller, for "*Improvements in ventilation, and in the apparatus or means employed therein.*" Aug. 26, 1871.

2247.—Karl Wenzel Zenger, professor of natural philosophy at the Polytechnic Institute of Prague, in Bohemia, in the empire of Austria, for "*A new method of manufacturing gas and graphite from mineral, vegetable, and animal coal, and from tar and other hydrocarbons.*" Aug. 26, 1871.

2250.—John Huish Webber, of King's Road, Chelsea, in the co. of Middlesex engineer, for "*Improvements in chimney-flues, and in apparatus connected therewith for warming and ventilating.*" Aug. 28, 1871.

2254.—George Haseltine, of the firm of Haseltine, Lake, and Co., Southampton Buildings, London, patent agents, for "*An improved method of and apparatus for utilizing the explosive force of gas as a motive power.*" A communication. Aug. 28, 1871.

2263.—William Webb, of 17, Evelyn Street, New Town, Deptford, in the co. of Kent, for "*Improvements in joints or connexions for uniting the ends of soft metal pipes to one another, and to other pipes and cocks and union-pieces.*" Aug. 28, 1871.

2274.—Henry Bright, of Leamington, in the co. of Warwick, for "*Improvements in the means and apparatus for drying sewage and other matters, and destroying noxious vapours arising therefrom.*" Aug. 30, 1871.

GRANTS OF PROVISIONAL PROTECTION.

2047.—James Hoeken, of 58, Fenchurch Street, in the City of London, engineer, and Francis George Fleury, of 24, Merrick Square, Southwark, in the co. of Surrey, engineer, for "*Improvements in water-waste preventers, or automatic apparatus for regulating the flow of liquids from constant supply pipes or vessels.*" Aug. 3, 1871.

2063.—George Goldsmith and James Dilkes, both of Leicester, in the co. of Leicester, for "*Improvements in apparatus for heating by gas.*" Aug. 4, 1871.

2109.—James Beckett and John James Cam, both of Worcester, in the co. of Worcester, engineers, for "*Improvements in treating sewage.*" Aug. 10, 1871.

2156.—John William Beasley, of High Street, Leyton, in the co. of Essex, plumber, for "*An improved ball-valve or tap for regulating the supply of liquids, water, steam, gas, or other fluids.*" Aug. 16, 1871.

2180.—Edwin John Grabham, of 107, Shepherdess Walk, City Road, in the co. of Middlesex, mechanical engineer, for "*Improvements in the apparatus used for regulating the supply of gas.*" Aug. 19, 1871.

2186.—William Williams, of Liverpool, in the co. of Lancaster, engineer, for "*Improved laystalls or receptacles for refuse of towns and other places.*" Aug. 19, 1871.

2250.—John Huish Webber, of King's Road, Chelsea, in the co. of Middlesex, engineer, for "*Improvements in chimney-flues, and in apparatus connected therewith for warming and ventilating.*" Aug. 28, 1871.

2254.—George Haseltine, of the firm of Haseltine, Lake, and Co., Southampton Buildings, London, patent agents, for "*An improved method of and apparatus for utilizing the explosive force of gas as a motive power.*" A communication. Aug. 28, 1871.

NOTICES TO PROCEED.

1140.—Henry Edward Mines, of Cheltenham, in the co. of Gloucester, engineer, for "*Improvements in lighting and heating, and in apparatus employed therefor.*" April 28, 1871.

1348.—Edmund Hunt, of Glasgow, in the co. of Lanark, N.B., for "*Improvements in gullies or stench-traps.*" A communication. May 19, 1871.

1897.—Ferrar Fenton, of Dewsbury, in the co. of York, for "*Improvements in the purification and utilization of sewage and other refuse matters, whether in a liquid, semi-fluid, or solid state, and in the extraction or production therefrom of 'magma,' 'seak,' grease, soap, tallow, or oil.*" July 20, 1871.

DUKE OF HAMILTON'S
LESMAHAGOW GAS COAL.

LESSEES:

LESMAHAGOW AND LONGLEE COAL COMPANY,

Office—5, DIXON STREET, GLASGOW.

Works—BLACKWOOD & SOUTHFIELD, LESMAHAGOW.

English and Foreign Agents:

JAMES MILLER, SON, & Co.,

1, GREAT ST. HELEN'S. LONDON, E.C.,

AND

75, UNION STREET, GLASGOW.

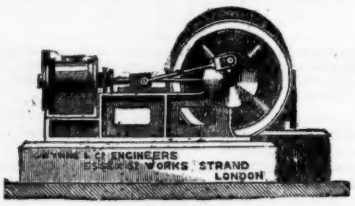

Fig. 213.

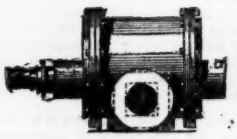

Fig. 211.

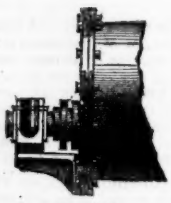

Fig. 219.

GWYNNE & COMPANY,

HYDRAULIC, MECHANICAL, AND GAS ENGINEERS,

ESSEX STREET WORKS, STRAND,

London, W.C.,

SOLE MANUFACTURERS OF

BEALE'S IMPROVED PATENT GAS-EXHAUSTER,

Under the personal superintendence of Mr. BEALE.

REDUCED PRICES AND INCREASED CAPACITY.

The Gas-Exhausters may be made with inside or outside bearing, as shown in Figs. 211 and 219.

The Slides now made by Gwynne and Co. are on the lap principle, with considerable improvements. Two of the largest Gas-Exhausters belonging to London Companies are now being altered to this principle.

Fig. 213 shows the Improved Gas-Exhauster attached to, and driven by one of Gwynne and Co.'s well-known high-speed Horizontal Steam-Engines, without any intermediate gearing. This arrangement is extremely compact, and is beautifully adapted for small or large Gas-Works, and the foundations and erection are both very simple and inexpensive.

Prices and every information upon application to Gwynne and Co. *as above.*

THE FARNLEY IRON COMPANY, LIMITED,

FARNLEY, near LEEDS,

Possess special advantages for the prompt and efficient execution of large orders for

FIRE-CLAY RETORTS & FIRE-BRICKS,

Of every shape and size, and of the best quality; also for their *other productions* in Fire-Clay and Terra-Cotta, including their well-known White and Coloured GLAZED BRICKS.

The F. I. Co. have the exclusive right to make and sell Fraser's Patent "Ribbed" Retorts in Fire-Clay.

Apply as above, or at their Offices,

3, WESTMINSTER CHAMBERS, VICTORIA STREET, S.W., or at 46½, QUEEN STREET, HULL.

FOREMAN GAS-FITTER.

WANTED, for a large provincial town, a thoroughly experienced Man as FOREMAN of gas-fitters and main-layers. He must be competent to make out estimates. Salary £140.

Applications, stating age, and enclosing copies of testimonials, to be addressed E. S. L., care of Mr. King, 11, Bolt Court, Fleet Street, E.C.

TO GAS COMPANIES.

WANTED, by the Advertiser, a situation as SMITH in a Gas-Work. Understands the laying of mains and services, and gas-fitting which might be required in Gas-Works. Country works preferred.

Address J. W., 39, Vauxhall Street, Kennington Lane, London.

WANTED, an Indoor Fitter, wages 30s. per week; an OUTDOOR FITTER, wages 32s. per week; and a SERVICE LAYER, wages 26s. per week.

Apply, with testimonials, at the Engineer's Office, Commercial Gas Company's Works, Stepney.

GAS MANAGER WANTED.

WANTED, early in October, as Working MANAGER of a small Gas-Work, where the make is about 3½ million feet per annum, a steady, active Man, who is practically acquainted with the manufacture of gas, and fully capable of conducting all the working arrangements of a small Gas-Work. One with a knowledge of plumbing and gas-fitting preferred. Dwelling-house, coals, and gas provided by the Company.

Address, stating age, salary expected, where last employed, and references as to character and ability, to the Secretary of the Gaslight Company, Ramsay, Isle of Man.

WANTED, Six Copies of "Gas Manipulation," by William Sugg, Edition 1867. Sixteen shillings per copy will be given for clean copies.

Address, William Sugg, Vincent Works, Vincent Street, Westminster, S.W.

A Young Man, aged 26, nine years in a Gas-Work (making 40,000,000 feet), desires a situation either as MANAGER or CHIEF RENTAL CLERK. Uses the photometer. Highest testimonials. No objection to go abroad.

Address Gas, care of Mr. King, 11, Bolt Court, Fleet Street, E.C.

A Gentleman seeks an engagement as ENGINEER to a railway company, large gas-works, or general contractor's establishment. Has been for many years connected with the construction and erection of bridges, wrought-iron girders, roofing, gas apparatus, tanks, &c. Can provide drawings, specifications, estimates, quantities, &c.

Address Alpha, Post-Office, Rochdale.

ON SALE, a good second-hand Station- METER, 8000 feet per hour, West and Gregson make, bye-pass, &c.

Apply to W. Longworth, Gas Offices, Dukinfield, Manchester.

TO GAS APPARATUS MANUFACTURERS AND OTHERS.

TO BE SOLD, at a very moderate price, A VALUABLE INVENTION,

Secured by Letters Patent,

for a more ready, convenient, and economical arrangement for

FASTENING THE LIDS OF GAS-RETORTS

than has hitherto been employed.

The Invention has undergone many months trial, with the most complete success, and can therefore be confidently recommended.

For particulars, apply to

Mr. W. H. BENNETT,

Patent Agent,

42, Parliament Street, Westminster, S.W.

TO GAS COMPANIES AND OTHERS.

THE Advertiser is open for an engage- ment as MANAGER, to enter on duties after September next. He has now the management of a Gas-Work where the make of gas is over 30 millions annually.

Apply to A. D., care of Mr. King, 11, Bolt Court, Fleet Street, E.C.

TO IRONFOUNDERS.

THE Wrexham Gaslight Company are in immediate WANT of from three to four miles of 4-in. or 6-in. CAST-IRON PIPES. Turned and bored joints preferred.

State weight per yard, and price, delivered at Wrexham Station.

FOR SALE, Three Dry Lime Purifiers, one 12 ft. by 8 ft. by 4 ft. deep, two 8 ft. by 6 ft. by 3 ft. 3 in. deep, with wrought-iron covers, travelling crane, and lifting apparatus, valves, and necessary 6-in. connexions.

For price, apply to J. Wilson, Gas-Works, Abingdon.

TO CONTRACTORS FOR BUILDING AND PROPRIETORS OF GAS-WORKS.

PART OF GAS-WORKS PLANT FOR SALE.

TO BE SOLD, by private Contract, a por- tion of the present Plant or Apparatus now recently in use at the Spalding Gas-Works, consisting of a set of 4-in. CONDENSERS, and a set of 6-in. Condensers respectively, with traps all complete. A set of four 6-ft. PURIFIERS, with centre-valve and lifting apparatus and connexions, also all complete.

The whole of the above Apparatus is in excellent condition, fit for immediate use, and disposed of only in consequence of larger Condensers and Purifiers being required for the Spalding Works. To those who are engaged in constructing or altering Gas-Works, to which these Condensers and Purifiers are, in regard to size, adapted, this presents an opportunity not always to be met with, as the articles offered will be sold at a reasonable price.

For price and further particulars, apply to Mr. John Woodward, Gas-Works, Spalding.

Aug. 30, 1871.

A SAD STORY.

AN EARNEST APPEAL is made to the Gas World and others on behalf of the WIDOW and Three Infant Children of the late Mr. FREDK. RICHARDS, who lost his life by a fall of sand while engaged in putting in the syphons for a gas-tank at the Wilmslow Gas-Works on the 5th inst., he being at that time Engineer and Manager for the Company. His family, by this calamity, is left TOTALLY DESTITUTE.

Contributions will be received and duly acknowledged in the JOURNAL OF GAS LIGHTING, by T. G. BARLOW, Esq., C.E., 42, Parliament Street, WESTMINSTER, who has kindly consented to act as Treasurer.

A Committee has been formed to administer the Fund, consisting of the following gentlemen, either of whom will be happy to receive contributions:—

Dr. BOWER, Surgeon, Wilmslow.
Mr. W. MABON, Ardwick Iron-Works, Manchester.
Mr. ALFRED PENNY, Wharf Road, City Road, London.

Subscriptions already acknowledged		£75 11 0
J. Randall, Tottenham		0 5 0
J. Paterson, Warrington		2 2 0
W. Wright, Lewes		0 10 6
T. Proud, Birmingham		1 1 0
R. K. Moorhouse, London		0 5 0
P. Watson, Stirling		0 10 0
Jabez Church, London		5 5 0
Samuel Rathbone		0 10 0
Edward Shipley		5 5 0
James Taylor	Per	2 2 0
Councllr. Woodward	W. Mabon	0 10 0
Thomas Peacock	and	0 10 0
S. Ogden	Co.	0 10 0
— Thomas		1 1 0
W. Yates		0 10 0
A. Malam, Dumfries		0 10 0
W. Davis, Hereford		0 9 0
W. Box, Crayford		0 10 0

SURREY CONSUMERS GAS COMPANY.

NOTICE is hereby given that the HALF-YEARLY ORDINARY GENERAL MEETING of the SHAREHOLDERS of this Company will be held at the Bridge House Hotel, London Bridge, Southwark, on THURSDAY, the 12th day of October next, at Three o'clock in the afternoon precisely, to receive the Directors Reprt for the half year ending the 30th of June last, and to declare a Dividend.

The Books for the Transfer of Shares will be closed on the 28th of September, until after the Meeting.

W. P. BODDY, Secretary.

Rotherhithe, Sept. 1, 1871.

CRYSTAL PALACE DISTRICT GAS COMPANY.

NOTICE is hereby given that the ORDINARY HALF-YEARLY GENERAL MEETING of this Company will be held at the London Tavern, Bishopsgate Street, in the City of London, on THURSDAY, the 28th day of September inst., to receive the Report of the Directors, the Balance-Sheet confirmed by the Auditor, as assisted by Mr. James Glaisher, to declare a Dividend, to elect an Auditor in lieu of Mr. W. Purvis, resigned, and for general business.

The Chair will be taken at Half-past Three o'clock precisely. By order of the Board,

MAGNUS OHREN, Secretary.

Offices, Lower Sydenham, S.E., Sept. 13, 1871.

COMMERCIAL GAS COMPANY.

NOTICE is hereby given that the next ORDINARY MEETING of the Company will be held at the London Tavern, Bishopsgate Street, in the City of London, on FRIDAY, the 6th day of October next, at Twelve o'clock at Noon, to receive the Report of the Directors, and to declare a Dividend to the 30th day of June last.

The Books of the Company will be closed for the Transfer of Shares from the 21st day of September to the 6th day of October now next ensuing.

By the Company's Act of Incorporation, Shareholders can inspect the Books of the Company during one fortnight before and one month after the Meeting.

By order of the Board,

GEORGE JAQUES, Secretary.

Stepney, Sept. 8, 1871.

SOUTH METROPOLITAN GASLIGHT AND COKE COMPANY.

NOTICE is hereby given that an ORDINARY MEETING of the PROPRIETORS of this Company will be held at the London Tavern, in the City of London, on MONDAY, the 2nd day of October next, at Two o'clock precisely, to receive the Directors Report and the Accounts of the Company for the half year ended the 30th of June last, and to declare a Dividend for the same period.

The Transfer Books of the Company will be closed from the 16th of September to the 2nd of October.

THOS. LIVESEY, Secretary.

Old Kent Road, Sept. 9, 1871.

MODERN STREET LIGHTING, by WILLIAM SUGG, A.I.C.E., price 1s. 6d., is now ready, and will be forwarded post free for 19 stamps.
W. Sugg, Vincent Works, Vincent St., WESTMINSTER, S.W.

THE Keighley Local Board of Health is prepared to receive TENDERS for the purchase of the TAR and AMMONIACAL LIQUOR produced at their works, for a term of One, Two, or Three years, commencing on the 1st of January, 1872.

For particulars, apply to the undersigned, at the Gas-Works, KEIGHLEY.

Tenders to be sent in on or before Thursday, the 28th inst., addressed to the Chairman of the Gas-Works Committee, and endorsed "Tender for Tar and Ammoniacal Liquor."

The Board does not bind itself to accept the lowest or any tender.—By order, J. LAYCOCK, Superintendent.

PRIVATE TELEGRAPHS FOR GAS AND WATER WORKS.

THE Electric Telegraph Department of our business is most efficiently conducted by an experienced staff. CONTRACTS entered into for maintenance and erection of lines for Gas and Water Companies, private residences, hotels, steamships, &c. Bailey's simple A B C instrument is stronger and less liable to derangement than any other in the market.

Sole makers of L. J. Crossley's Electrical Speed Indicator.

Sole makers of Chatwood's Patent Electrical Ship's Log.

Sole makers of Bailey's dust-proof and damp-proof Signal-Bell.

Managers of Gas and Water Works are invited to ask us for our quotations, or for any information connected with Telegraphy.

JOHN BAILEY AND CO., Turret Clock Makers to the late Earl of Rosse, the British and Foreign Governments, &c., Electric Telegraph Engineers, and General Brassfounders, Albion Works, Salford, MANCHESTER.

MANUFACTURE AND DISTRIBUTION ACCOUNTS.

Mr. W. J. WARNER

Begs to say that in consequence of the number of inquiries he has received relative to the above form of Accounts, which he had the pleasure of submitting to the

BRITISH ASSOCIATION OF GAS MANAGERS, AT THEIR LATE MEETING IN DUBLIN,

he has been induced to publish them, and is now prepared to supply the two sheets, post free, for 5s.

Applications to be made to

Mr. W. J. WARNER,
Engineer,
GAS-WORKS, SOUTH SHIELDS.

ALFRED LASS,
ACCOUNTANT,
28, NORTH STREET, WANDSWORTH, S.W.

Mr. Alfred Lass having had considerable experience in arranging, making up, balancing and auditing gas accounts, begs to inform the Directors of Gas Companies that he may be consulted on all matters relating thereto.

Balance-sheets prepared, Accounts audited, Consultations, Agencies, &c.

BOOKS FOR GAS ACCOUNTS.

ALFRED DOUBBLE & Co., 2, Serjeants INN, and 40, FLEET STREET, LONDON, make and supply all the various ACCOUNT-BOOKS as approved and adopted by Accountants, &c., to Gas Companies.

A complete set of the Books and Forms forwarded within a few days from receipt of order.

EDWARD SANDELL, Public Accountant and Auditor, 4, Skinner's Place, Size Lane, LONDON.

The projector of the *Original Gas Companies Analyzed Expenditure Account-Book* offers his experience and services in the examination, preparation, and production of all accounts in reference to Gas Companies. References if required.

SAMUEL PONTIFEX, Consulting Gas Engineer, having retired from the Great Central Gas Company, is now prepared to furnish PLANS and SPECIFICATIONS, as well as ADVISE Provincial Gas Companies as to the erection of new, or alteration and enlargement of existing works.

Offices: 22, Coleman Street, LONDON, E.C.

ALFRED PENNY, Gas and Consulting ENGINEER,
WENLOCK IRON-WORKS,
21, WHARF ROAD, CITY ROAD, LONDON.

Mr. PENNY having had a large experience in the construction, alteration, and management of Gas-Works, begs to inform the Directors of Gas Companies that he may be consulted on all matters appertaining thereto. He also manufactures Gasholders, Purifiers, and all the various apparatus used in Gas-Works, and keeps in stock Retorts and Mouthpieces, Socket-Pipes, Bends, Branches, and T-pieces, &c., &c.

Plans, Specifications, and Estimates prepared.

TO INVENTORS AND PATENTEES.

MR. W. H. BENNETT, having had considerable experience in matters connected with Gas, Water, and Sanitary Improvement, begs to say that he continues to assist Inventors in the perfection of their designs, and to obtain for them PROVISIONAL PROTECTION, whereby their invention may be secured for Six Months; or LETTERS PATENT, which are granted for Fourteen Years.

Patents completed, or proceeded with at any stage, thereby rendering it unnecessary for persons resident in the country to visit London.

Patents procured for Foreign Countries.

Information as to cost, &c., supplied gratuitously upon application to the Advertiser, 42, Parliament Street, WESTMINSTER. [Office of the JOURNAL OF GAS LIGHTING, &c.]

BRONNER'S PATENT GAS-BURNERS give 99 per cent. of light, as compared with 27 per cent. given by ordinary burners, with equal consumption of gas.—*Vide* "Gas Referees Report," published June, 1869.

HENRY GREENE AND SON, Sole Consignees of Brönner's Patent Improvements in Gas Lighting, 16 and 17, King William Street, E.C., and 138, Regent Street, LONDON. Agents wanted.

THE Maryport Town and Harbour Gas Company OFFER FOR SALE their Lamp-Posts and Lamps.

For prices, &c., apply to COLIN B. DARWIN, Secretary.

EDGE'S PATENT
FOR REMOVING THE
CARBONACEOUS INCRUSTATION FROM GAS-RETORTS,

Testimonial of Mr. W. Ford, Engineer of the Stockton Corporation Gas-Works.

"Dear Sir,—In reply to your inquiry as to my experience of Edge's patent method for removing the Carbonaceous Incrustation from through Retorts, I have much pleasure in expressing my thorough appreciation of the process; it has been the means of saving our stokers many hours hard work, and the Retorts much serious destruction.—I am, dear sir, yours truly, "W. FORD.

"To E. Goddard, Esq., Ipswich."

For particulars and terms, apply to E. GODDARD, Sole Agent, Gas-Works, IPSWICH.

CAST-IRON Retorts, Socket-Pipes, with Syphons, and all requisite Connexions, Lamp Columns, Wrought-Iron Tubing, Valves, Street-Lamps, Sight Holes, Furnace Doors, Ash-Pans, Charging and Coke Shovels, Iron Pails, Coke Barrows, Cross Bars, Fire Pots, Pumps, and Iron Borings.

PURIFIERS, CONDENSERS, & SCRUBBERS erected complete, or the materials supplied; and every description of goods in use by Gas-Works, in stock, at wholesale prices, at

Mr. LYNCH WHITE'S,
Old Barge Iron Wharf, Upper Ground Street, LONDON.

HOPKINS, GILKES, & CO.,
LIMITED,
MIDDLESBOROUGH,
SUPPLY GAS & WATER PIPES of EVERY SIZE.
Plain, Turned and Bored, and Coated.
CAST-IRON RETORTS.
Castings for Gas-Works of every description.
EXHAUSTERS.
LONDON OFFICE: 25, LAURENCE POUNTNEY LANE.

TROTTER, HAINES, & CORBETT,
BRETTELL'S ESTATE
FIRE CLAY & BRICK WORKS,
STOURBRIDGE.

Manufacturers of GAS-RETORTS, GLASS-HOUSE FURNACE & BLAST-FURNACE BRICKS, LUMPS, TILES, and every description of FIRE-BRICK.

Proprietors of
BEST GLASS-HOUSE POT and CRUCIBLE CLAYS.
Successors to
E. BAKER AND CO., LATE BRIERLEY HILL, STAFFORDSHIRE.

THOMAS CARR & SON,
MANUFACTURERS OF
FIRE-BRICKS, LUMPS, TILES, RETORTS,
&c., &c.,
SCOTSWOOD FIRE-BRICK WORKS,
NEAR
BLAYDON-ON-TYNE.

THOMAS EDINGTON & SONS,
PHŒNIX IRON-WORKS,
GLASGOW,
MANUFACTURERS OF
GAS AND WATER PIPES,
All sizes up to 4 ft. diameter;
RAILWAY CHAIRS AND SLEEPERS,
and general Castings. Also
GREGORY'S & COCKBURN-MUIR'S
PERMANENT WAY.
London Office: 63, OLD BROAD STREET, E.C.

WALTER MABON & CO.,
Engineers,
ARDWICK IRON-WORKS,
FAIRFIELD STREET, MANCHESTER,
MANUFACTURERS OF
IRON TANKS, GASHOLDERS,
GAS APPARATUS,
PIPES, VALVES, IRON ROOFS,
WROUGHT AND CAST IRON GIRDERS.

DESIGNS, SPECIFICATIONS, & ESTIMATE FURNISHED.

WATER-WORKS FITTINGS,
SLUICE-COCKS, FIRE-COCKS,
METERS, STEAM FITTINGS,
GAS & HOT-WATER VALVES, &c.,
Of First-class Materials and Workmanship.

BECK & CO., Limited,
BRASSFOUNDERS & HYDRAULIC ENGINEERS,
GREAT SUFFOLK STREET, SOUTHWARK, S.E.
Illustrated Catalogues on application.

THOMAS PROUD,

GAS ENGINEER,

CONTRACTOR FOR GAS-WORKS,

AND FOR

LAYING MAINS FOR GAS AND WATER,

Respectfully invites attention to his

Wood Grids for Purifiers and Scrubbers,

which he manufactures by improved Steam Machinery from well-seasoned Timber.

Also to his IMPROVED GAUGE, which indicates Pressure or Vacuum in ONE TUBE.

Experienced Workmen sent out for setting Retorts and erecting Apparatus.

7, UNETT STREET, St. GEORGE'S,

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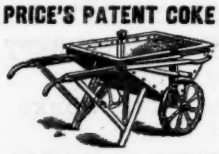

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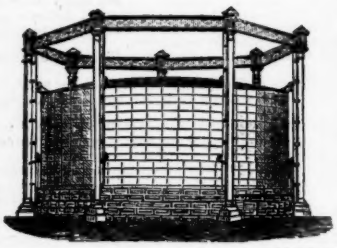

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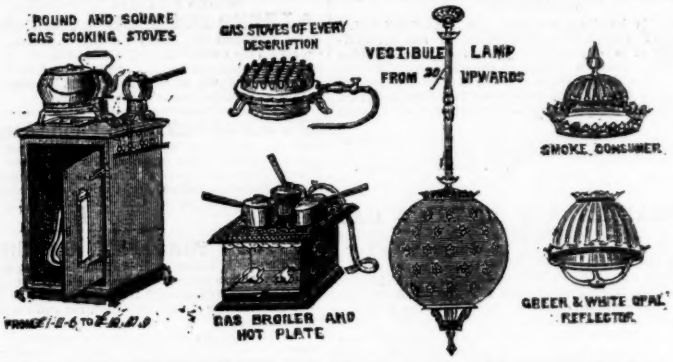
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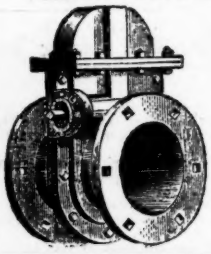

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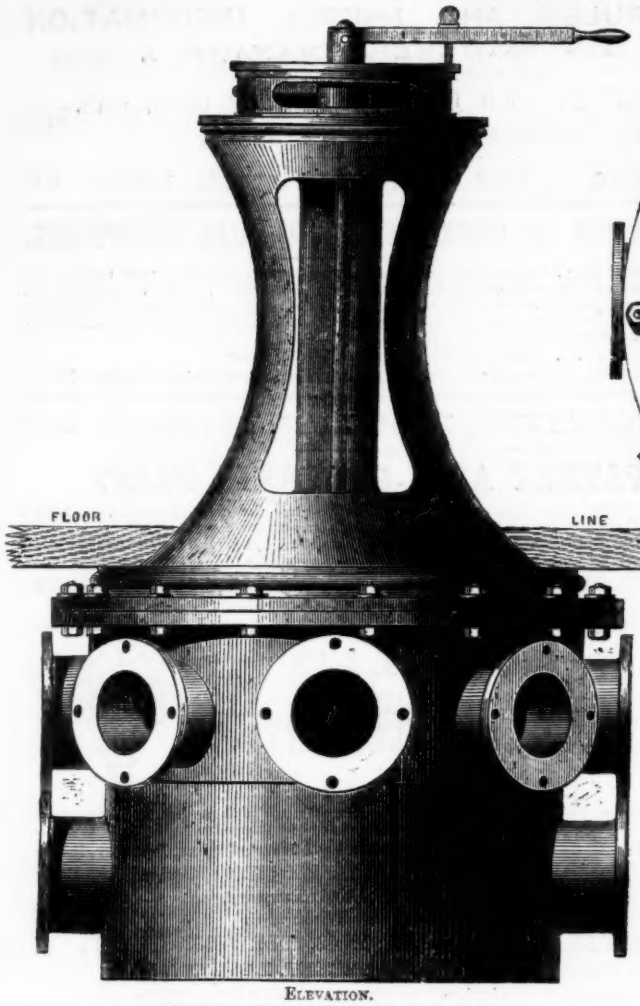

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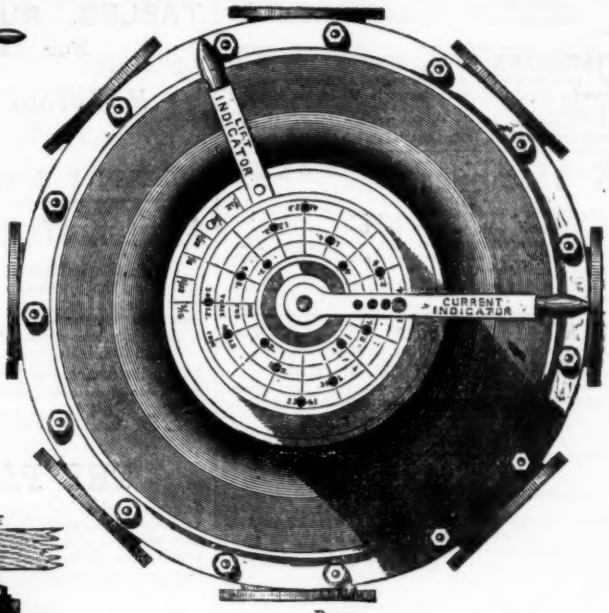
CENTRE-VALVE FOR FOUR PURIFIERS.



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These Valves are adapted for every purpose and position about gas-works, &c. They are constructed on the principle of the ordinary plug-cock, the internal cones or plugs being formed with divisions, and both the cones or plugs and bodies of the Valves are *recessed* in such a manner that no part of the working surface is exposed to or in contact with the gas, *thus securing a minimum of friction*, and also the preservation of the working surface *from deposit or deterioration.*

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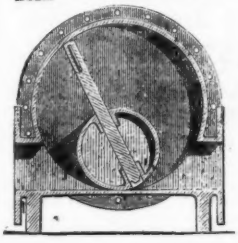

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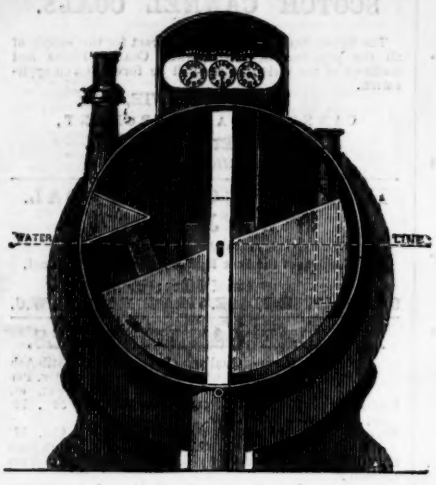

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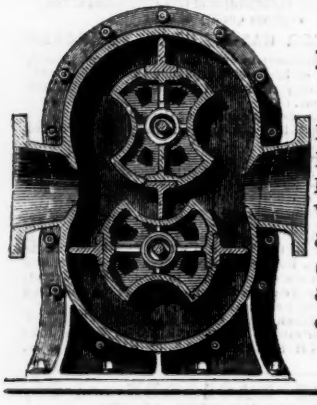

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